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Abstract

Arizona state statutes require new developments within Active Management Areas (AMA) to demonstrate a 100-year assured water supply (AWS) for their projected demands before a lot can be sold to a potential homeowner. There are different options which an applicant can use to meet this requirement. Most municipalities choose to obtain a Designation of AWS (Designation) as described in Arizona Revised Statutes §45-576. The Designation is reviewed annually and is set for a set volume of water over a set period of time. At the end of the specified period of time the Designated water provider must apply to modify the Designation (re-Designation). A part of the Designation process requires the applicant to demonstrate that water pumped from the ground (both groundwater and recovered water) is physically available. In the Phoenix AMA physical availability is defined as the volume of water above 1,000 feet below land surface (bls) or above bedrock (whichever is less) after 100 years. This report details the process and assumptions that went into demonstrating physical availability for the applicants seeking re-Designation of their existing AWS determinations (Applicants[1]) in the Phoenix AMA.

The Arizona Department of Water Resources (Department) Salt River Valley (SRV) groundwater flow model (Freihoefer et.al, 2009) was used as the modeling tool to demonstrate physical availability. Numerous scenarios were developed as part of the re-Designation process. The various scenarios were input into the groundwater flow model and run to project the impacts to the aquifer over the 100-year time period.

All of the scenarios took into account the same base assumptions such as; model boundary conditions, the effects of urbanization on agricultural pumping and recharge, non-municipal recharge, and non-municipal pumping. A baseline scenario was created using the 2010 or current Designation AWS volumes for the Applicants and recharging the available surface water after the Applicants' 2010 demands were met. This scenario provided a view of the conditions of the aquifer after 100 years if current AWS demand conditions did not change. This scenario provided a baseline to compare all other scenarios with. This scenario showed that the major effects of pumping on the aquifer

were generally along margins of the regional aquifer system. As expected, this same pattern of impact was common, in varying degrees, in the rest of the scenarios.

The first re-Designation scenario, Scenario 1, was based on data provided by the Applicants and the Salt River Project (SRP). These entities provided their groundwater pumping by well, recovery of Long Term storage Credits (LTSCs) by well, and the projected volume of recharge by storage facility. SRP provided estimates on pumping based on their long term historical pumping data. The data was provided for the period from the year 2008 to 2025. For the 100-year projection all the data after the year 2025 was held constant out to the year 2108. This Scenario showed significant areas where the water level dropped below 1,000 ft. bls at the end of the 100-year projection in the West Salt River Valley (WSRV) and in the northeastern corner of the East Salt River Valley (ESRV). It was determined that alternate scenarios would be required to have a better understanding of what volumes of increased demand could be added to the Salt River Valley Basin and still satisfy AWS limitations for physical availability.

A second scenario (Scenario 2) was created based upon the groundwater and recovery demands that would be required if the Applicants used eighty percent of their treatment capacity of surface water that was reported to be available from their applications. This reduced the projected pumping by the Applicants by a total of 160,734 acre-feet per year (af/yr) for the period from 2025 to 2108. The volume of artificial recharge was adjusted (downward) to reflect that more of the surface water would be used directly and therefore less would be available for recharge (a reduction in projected annual recharge of 77,409 af/yr from 2025 to 2108). The volume of SRP pumping was reduced to reflect a lower annual demand based on the average SRP pumping from 1984 to 2008. This resulted in an overall reduction of projected SRP pumping by 94,411 af/yr. The changes in pumping and recharge decreased the overall impact that was seen in Scenario 1 for the 100-year projection. However, this scenario still showed significant areas that did not meet AWS physical availability depth to water criteria.

A third scenario (Scenario 3) was developed using the same base assumptions as Scenario 2 except the Applicants' demand was based on their projected demands from the year 2020 instead of the year 2025. With the groundwater and recovery demands based off of the applicants demand projections for the year 2020 and using eighty percent of their treatment capacity of available surface water, an annual reduction of 64,881 af/yr of pumping was projected compared to Scenario 2. This scenario resulted in projections that indicated that the Applicants' pumping wells would neither dewater nor drop below 1,000 ft. bls in the next 100 years.

The fourth and final scenario (Scenario 4) was similar to Scenario 3 except for the following changes. The final scenario reflects the additional recovery of LTSC within the "safe harbor" of Underground Storage Facilities (USFs), along with a few adjustments to the projected recharge and pumping by the Applicants. The projected recharge was altered to reflect the Applicants recharging at facilities with associated recovery wells. Projected Central Arizona Groundwater Replenishment District (CAGRD) recharge at two facilities in the Hassayampa subbasin was moved to the Superstition Mountain USF in the ESRV, based on discussions with the CAGRD. Over the model area these changes resulted in a net increase in demand of approximately 2,500 af/yr compared to Scenario 3. Scenario 4 shows less of a contrast between the low depth to water (DTW) areas and the higher DTW areas then other scenarios. Overall Scenario 4 is an improvement over the previous scenarios concerning the impact to the aquifer and demonstrates the advantage of strategically locating pumping and recharge.

The main purpose behind these model scenarios was the re-Designation process, however, the scenarios also provide valuable water planning tools. The model scenarios not only take into account varying pumping and recharge amounts from the applicants but also the relationship between recharge and recovery, utilization of LTSC, urbanization of agricultural related pumping and recharge, and the difference between the direct use and recharge of surface water. By analyzing and comparing the results of the difference scenarios water planners have a better understanding of how to mitigate the impacts that are predicted for the future.

Acknowledgements

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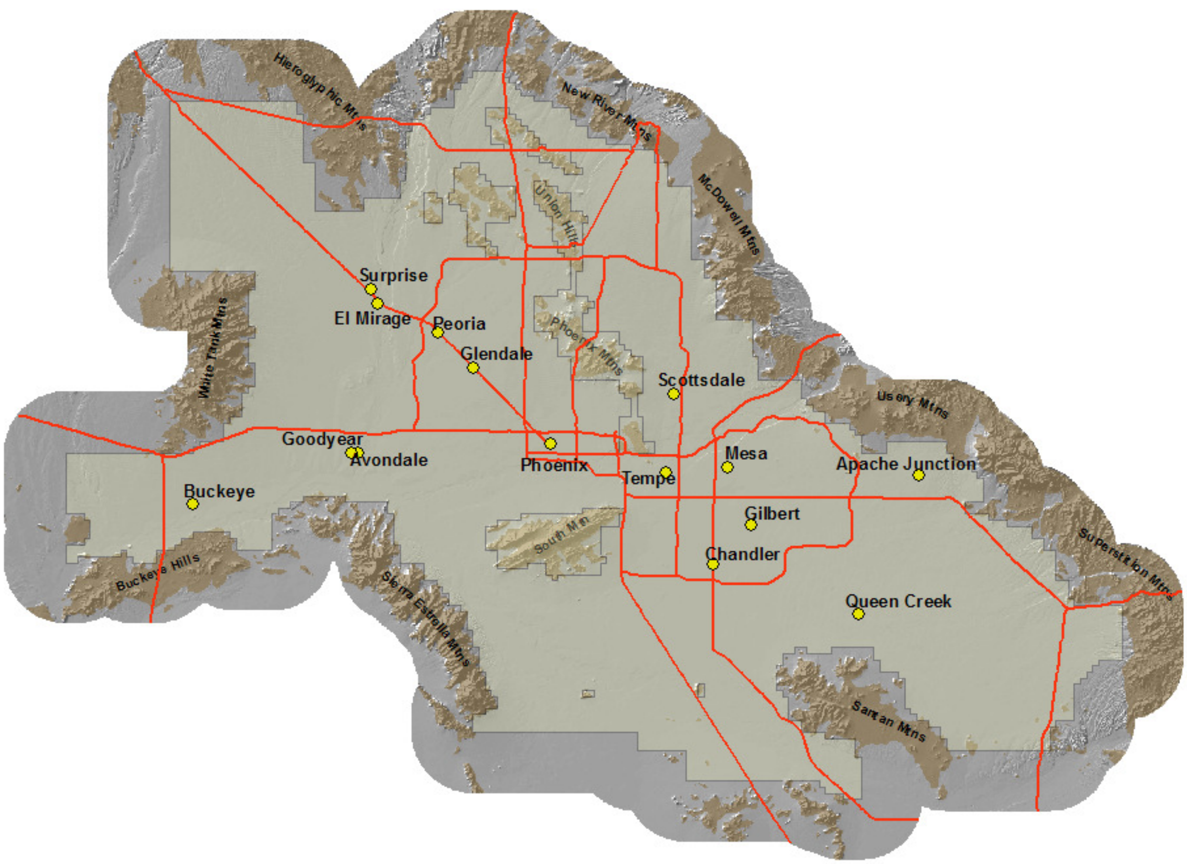
Numerous individual have provided information, suggestions, comments, and assistance during the progress of the modeling portion of this project and the development of the report. Special thanks go to the following: Scott Miller of the Phoenix AMA for his partnership in this process; Lou Bota from Department's Water Resource Section and Kade Hutchinson from Department's Modeling Unit for their assistance in the model runs that were done for this project; Steve Rascona, Alene McCracken, and Lisa Dubas for there assistance in developing and checking key portions of the scenario data; Frank Corkhill and Sandra Fabritz-Whitney for their assistance in the review of this document.

ARIZONA DEPARTMENT OF WATER RESOURCES

A SALT RIVER VALLEY GROUNDWATER FLOW MODEL APPLICATION

100-YEAR PREDICTIVE SCENARIOS USED FOR THE DETERMINATION OF PHYSICAL AVAILABILITY IN THE PHOENIX ACTIVE MANAGEMENT AREA



MODELING REPORT NO. 22

BY

WESLEY HIPKE

HYDROLOGY DIVISION
PHOENIX, ARIZONA
JULY, 2010

1.0 Introduction

This document details various 100-year predictive scenarios that were developed as part of the Assured Water Supply (AWS) re-Designation process. This document discusses assumptions common to all scenarios, assumptions specific to each scenario, and the variations in the pumping and recharge volumes used in the scenarios, and the results of the scenarios.

1.1 Background

The Department's AWS Program was created as a consumer protection program for homebuyers and to protect and preserve limited groundwater supplies within Active Management Areas (AMAs). One method used to accomplish this goal is for water providers to obtain a Designation of AWS (Designation) for their water service area. There are numerous criteria that must be met for a water provider to demonstrate a 100-year AWS. One of the criteria is for the applicant to demonstrate that the portion of their projected demand that is to be met by water pumped from the ground is physically available. In the Phoenix AMA an applicant's projected pumped water is determined to be physical availability if after 100 years this volume of water does not cause the water level of the aquifer to drop below 1,000 feet below land surface (bls) or reach bedrock, in the area of the applicants withdrawals. The impact of an applicant's proposed pumping after 100-years must also not negatively impact other issued AWS demands by causing the water level at the locations of withdrawals to drop below 1,000 feet bls or reach bedrock.

When the Applicants applied for their original Designation in the late 1990's the Department was faced with the problem of how to determine physical availability from multiple applications and the combined effect the demands would have on the aquifer. The Department determined the most efficient solution was to work with all the applicants applying for Designation to develop a single groundwater model scenario. The model scenario demonstrated the physical availability for all the applicants projecting their combined groundwater demand over a 100-year period.

With many of the water provider's Designations expiring around the year 2010 the Department was again faced with how best to determine the physical availability from numerous applicants over an entire basin. In the interests of efficiency for the Applicants and the Department, the Department offered to do the groundwater modeling work required to analyze the physical availability for the Applicants seeking re-Designation. This report details the work, assumptions, and results of Department's groundwater modeling efforts for the re-Designation process in the Phoenix AMA.

1.2 Purpose and Scope

The modeling scenarios are only a portion of the requirements for a water provider to demonstrate an AWS. The purpose of this modeling effort was to simulate groundwater conditions in the Phoenix AMA to determine if the Applicants meet the requirements for proof of physical availability as defined by the AWS Rules (See Arizona Administrative Code R12-15-716). This report focuses only on documenting the modeling effort, the assumptions that went into the various scenarios, and the results of those scenarios. Figure 1 shows the location of the study area including the Phoenix AMA and the SRV Model.

2.0 SRV Groundwater Flow Model

2.1 History

The Department's original Salt River Valley (SRV) groundwater flow model was published in two phases. The first phase documented the hydrogeologic framework and the basic data requirements of the model (Corkhill and others, 1993). The second phase documented various inputs and features of the numerical model (Corell and Corkhill, 1994). Since that time, the model has been periodically updated to account for new geological data, water level data, pumping information, or recharge data. As new information became available the MODFLOW packages were updated, or converted to newer versions of MODFLOW. For more detailed information concerning the updates please refer to the following documents: Hipke et.al, 1996; Bota et.al, 2004, and Freihoefer et.al, 2009.

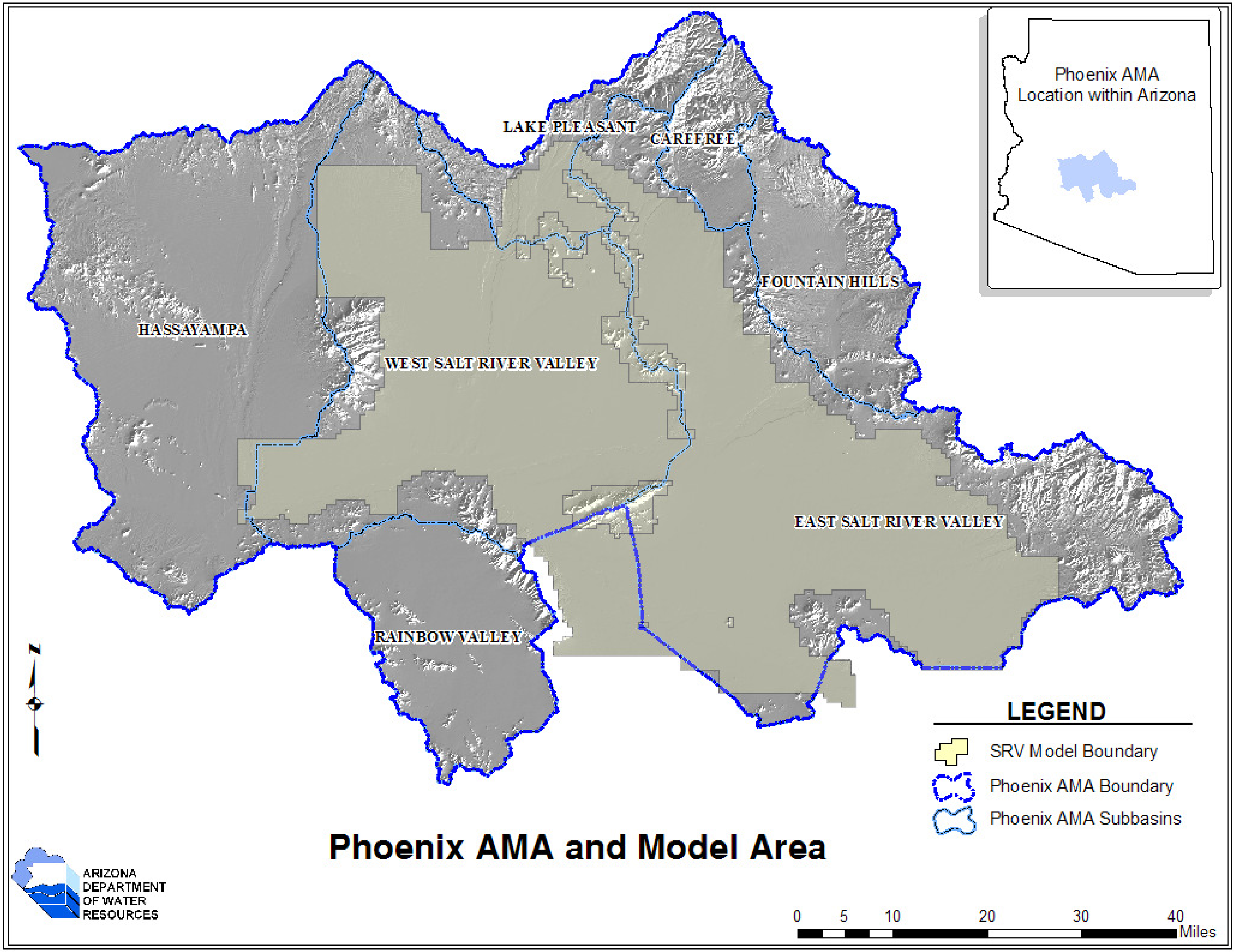


Figure 1. Re-Designation Study Area (SRV Model Boundary) and the Phoenix AMA.

2.2 Model Development

The Department's most current version of the SRV model, calibrated from 1983 to 2006, was used as a base for the scenarios developed for the re-Designation process. This model is a significant update from previous models and includes a finer grid, updated geology, and an expanded model area. For a more detailed discussion of the model used please refer to Freihoefer et.al, 2009. The model report and the 1983 to 2006 model datasets can be downloaded from the Department's Modeling web site (www.azwater.gov/AzDWR/Hydrology/Modeling). Figure 1 shows the relationship between the boundaries of the Phoenix AMA and the geographic extent of the SRV groundwater flow model. This report only focuses on the development of the projection scenarios and the overall results of the various model scenarios that were run. In the rest of this document this model will be referred to as the SRV Model.

3.0 Scenario Development

When developing predictive model scenarios one of the most important aspects to consider is, "What question do you want the results of the predictive scenario to answer?". In this case, the predictive scenario is used to determine if the groundwater demand from the Applicants meets the AWS requirements for physical availability. With that goal in mind, assumptions were developed that would account for the AWS physical availability requirements. The assumptions that were developed fit into two categories, modeling assumptions and scenario assumptions. Modeling Assumptions are assumptions that do not change from one scenario to another. For example, the projected Mountain Front recharge in the model is held constant for all of the scenarios for the 100-year projection period. The scenario assumptions deal with changes in the Applicants' projected pumping and recharge that is included with their re-Designation application or other changes that vary from one scenario to another. All assumptions for each scenario remain constant for the projection period from 2025 to 2108.

3.1 Modeling Assumptions

The modeling assumptions were designed to provide reasonable inputs, from an AWS point of view, to predict stresses on the model for 100-years. These assumptions remain constant through all of the scenarios for the re-Designation process. These assumptions cover a wide range of subjects from boundary conditions to the model, non-municipal pumping, previously issued AWS pumping, and projections for various types of recharge. Some of the assumptions were based upon requirements for demonstrating an AWS while others are considered reasonable estimates for 100-year predictions of stresses on the aquifer. The pumping recorded in the Department's Registry of Grandfathered Rights (RoGR) by well for the year 2007 was used as a base for projecting pumping into the future.

3.1.1 Issued AWS Groundwater Demands

Issued AWS groundwater demands are groundwater demands in AMAs that have been issued by the Department in the form of AWS Designations, Certificates, or Analyses of AWS. Issued AWS demands were obtained from the Departments' AWS Database as of May 30, 2010. The demands were extensively reviewed and verified by both the Department's Hydrology Division and the Water Management Division. For this study these demands do not include the issued AWS demands for the Applicants applying for re-Designation. The data were checked to ensure that all transfers of permits were accounted for and Analyses of AWS and Physical Availability Determinations were reduced as Certificates were issued off of them.

To determine the geospatial distribution of the issued AWS demands an AWS "well" database was created. The database was populated from the Department's RoGR database with wells that were reported to have pumped pursuant to issued AWS demands. The wells that were drilled and permitted by the year 2007 for these AWS determinations, but had not reported any pumping were also added to the AWS well database. The wells, drilled after 1983 (post-code wells), were limited to the well's maximum permitted annual groundwater withdrawal volumes. Pre-code wells (wells drilled before 1983) were simulated at their highest reported annual groundwater volume listed in the RoGR database. If the recorded wells did not have the capacity to meet the total issued AWS demand for a specific water provider, hypothetical AWS wells were added for that water provider. The hypothetical wells locations and groundwater withdrawal volumes were based on proposed well locations and volumes listed in the hydrologic studies submitted by the water provider with their applications. In some cases the total pump capacity was still less than needed to meet the issued AWS demands for that provider. In these cases the pumping volumes of the wells were increased, within reason to meet the issued AWS demands. Figure 2 shows the general locations of the wells used to simulate the pumping of the issued AWS demands. Issued AWS demands outside of the SRV Model area were not simulated in the predictive scenarios. All of the projected issued AWS demands were considered to be groundwater (i.e. none of the demands were met by simulated recovery of LTSCs or other renewable water supplies).

Figure 3 shows the relationship between the historical pumping pursuant to existing AWS determinations and the projected issued AWS demand volumes used for the scenarios. From 2008, the projected pumping increases from over 182,000 af/yr to slightly over 269,000 af/yr. This increase represents the volume of groundwater demand for issued AWS determinations in the study area that, as of 2007, were not being served.

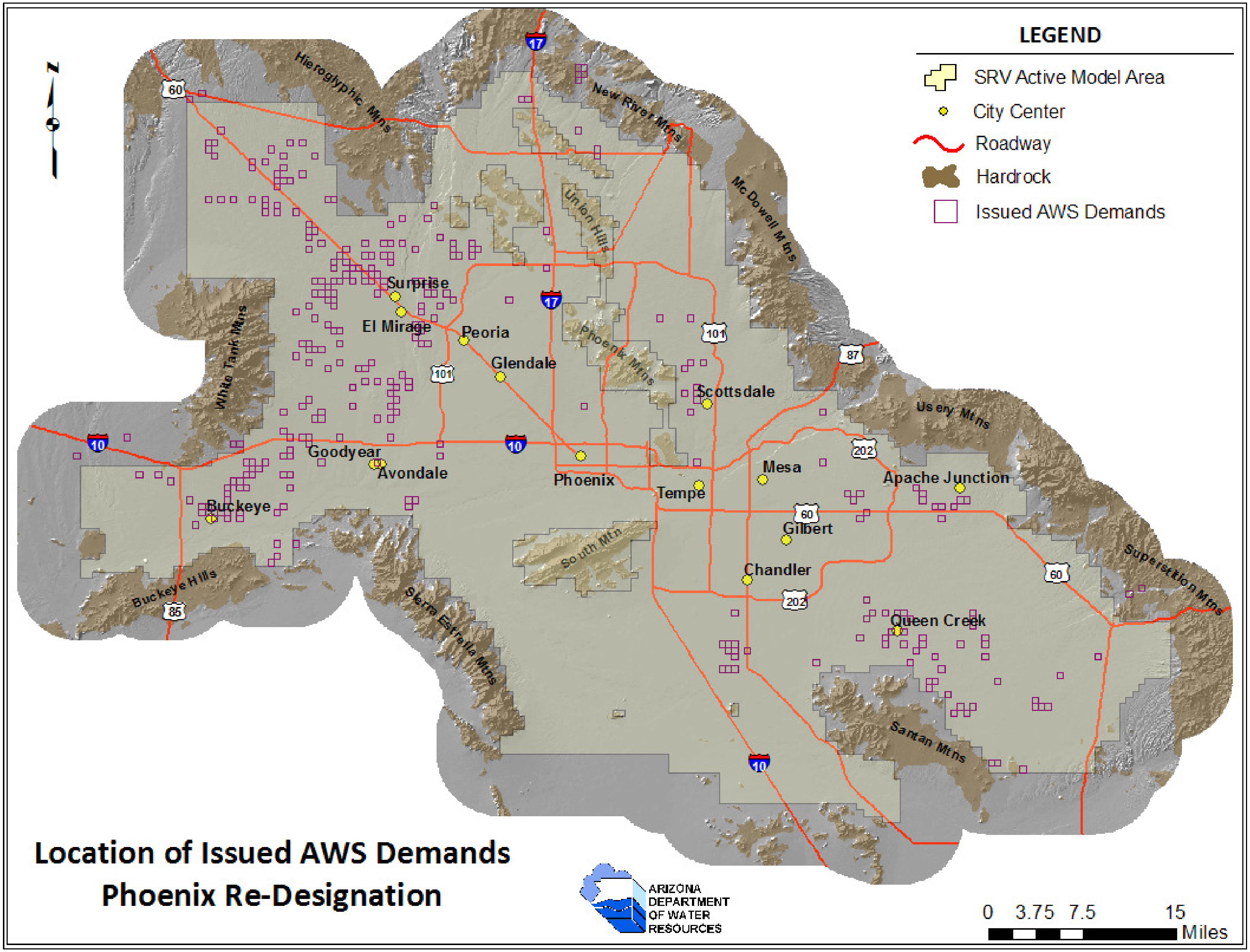


Figure 2. Location in the SRV Model of Issued AWS Demands.

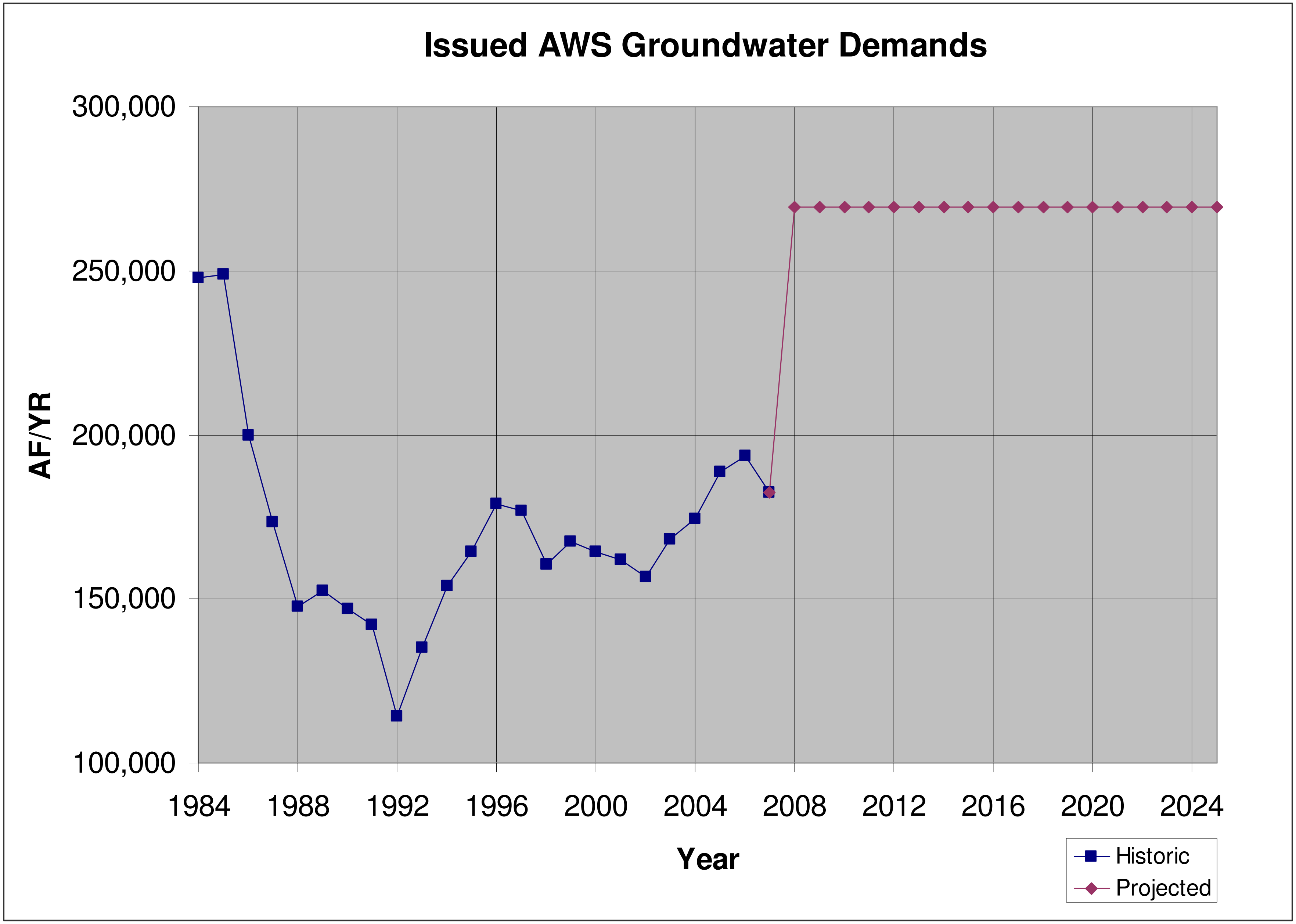


Figure 3. Volume of Issued AWS Demands Historic and Projected.

3.1.2 Agricultural Groundwater Demands

As the Phoenix AMA develops, it is predictable that agricultural and irrigation district pumping will not continue at historic levels as the agricultural lands are urbanized. The following process was developed to account for the change in agricultural and irrigation district pumping due to urbanization over the projection period between 2008 and 2025. The Department categorizes agricultural pumping under two right types, irrigation grandfathered rights (Right Type 58) and irrigation district pumping (Right Type 57). The reported pumping volumes and distribution of that pumping for irrigation grandfathered rights and irrigation districts reported pumping were obtained from the Department's RoGR database for the year 2007 were used as a base for agricultural pumping. Figure 4 shows the distribution of the irrigation district wells and irrigation grandfathered right wells in the SRV Model for the year 2007.

To reasonably project the agricultural pumping into the future a method was created to turn the agricultural pumping off as the land urbanized. This method used predicted population data to determine when an area would urbanize. Once an area urbanized the agricultural pumping was turned off in the predictive scenario. The Department used a similar process for the predictive model work that was done for the Salt River Valley in the later part of the 1990's (Hipke, et.al., 1996) and for the East Valley Water Forum (Hipke, 2007).

The following irrigation district wells were exceptions to the urbanization process: Salt River Project (SRP) and Roosevelt Irrigation District (RID). The assumption for the wells that are exempt from urbanization is that even though the land around the well urbanized, the well would continue to be used. Historically, in the case of SRP this has proven to be true. SRP is by far one of the largest irrigation districts in the Phoenix AMA with an extensive distribution system. Even though a SRP well is in a completely urbanized area the well is still pumped to supply water for other areas. RID's irrigation district extends past areas that are predicted to urbanize and it has the distribution system that would allow it to distribute water to these areas. Therefore these wells were also not subject to urbanization.

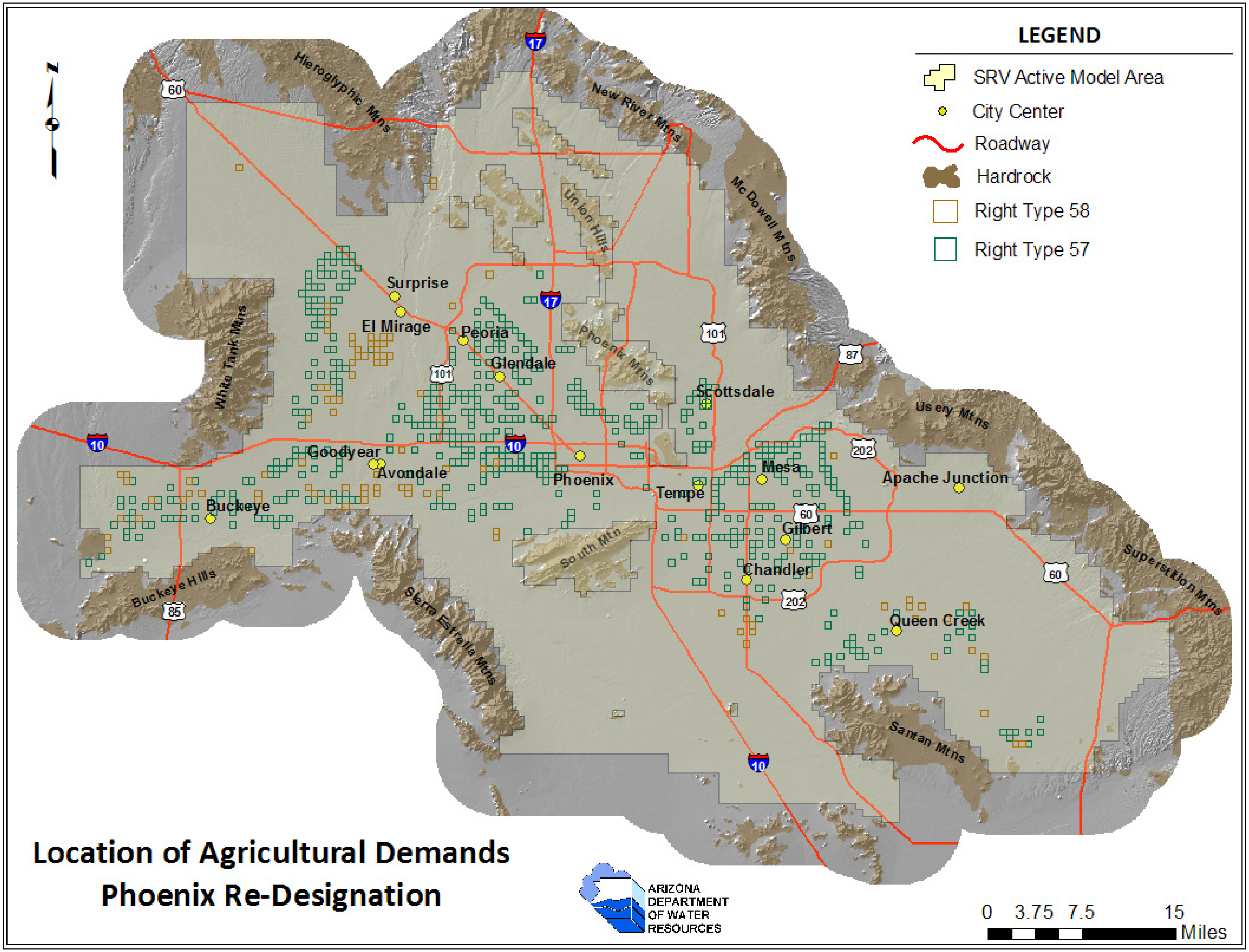


Figure 4. Distribution of Agricultural Demands for the year 2007.

The population projections were a combination of projections obtained from the Maricopa Association of Governments (MAG) and the Central Arizona Association of Governments (CAAG). These projections were combined with the SRV model grid using standard GIS techniques to cover the entire study area. A model cell was then calculated to urbanize if at least 50 percent of a model cell (1 square mile) was predicted to have one housing unit per acre. For any model cell that urbanized in a five-year period, the agricultural and irrigation district pumping was removed from that period forward. This process was accomplished by using the Department's Water Demand Decision Support System (WD-DSS) application.

A breakdown of the irrigation grandfathered rights and irrigation district pumping volumes for the projection period is shown in Table 1. The irrigation district projected demands do not reflect SRP pumping. SRP information used for the scenarios is discussed in more detail in later sections. Figure 5 shows the relationship between the historic pumping (1984 to 2007) and the projected agricultural pumping (2008 to 2025).

Table 1. Projected Agriculture and Irrigation District Groundwater Demand
(acre-feet/year)

	2008	2010	2015	2020	2025
Irrigation District[1]	230,256	229,449	225,966	221,529	218,914
IGFR	47,490	47,091	42,743	40,693	38,242
GSF Agriculture	95,490	95,400	83,232	81,336	79,458
TOTAL	**373,236**	**372,161**	**351,941**	**343,558**	**336,614**

[1] Irrigation District projected pumping volumes does not include projected volumes for SRP

Pumping was also added to the projection period to replace renewable water supplies that are currently being delivered to Groundwater Savings Facilities (GSFs). Therefore the assumption that the water being delivered to obtain LTSCs at GSFs is legally accounted for in the agricultural demand as groundwater pumping within the boundaries of the GSFs. The volume of groundwater pumping was determined by using reported 2007 volumes of renewable supplies delivered to the GSF to obtain LTSCs.

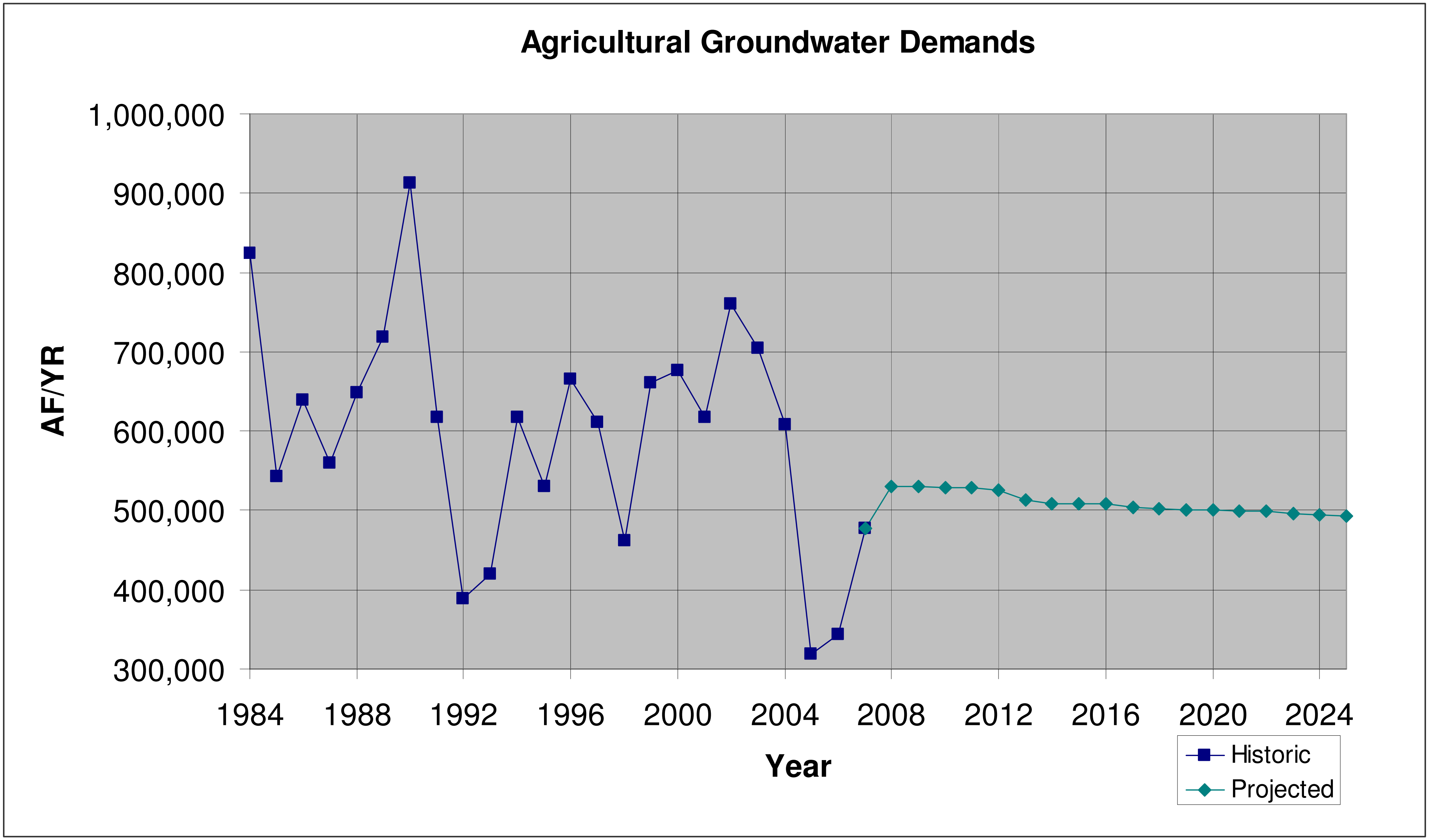


Figure 5. Volume of Agricultural Demands, Historic and Projected.

Figure 6 shows were this demand was distributed in the SRV Model. This does not include water delivered for CAGRD replenishment, that topic will be discussed in Section 3.1.5.

3.1.3 Exempt Well (Domestic) Demands

Exempt wells are defined as wells that pump no more than 35 gallons per minute (gpm). Owners of exempt wells are not required to report the volume of groundwater that they pump. The projected domestic well demand was calculated using rates published in the Phoenix AMAs Third Management Plan (Arizona Department of Water Resources, 1999) of 0.3699 acre-feet per household. This rate was applied to the Department's Modeling Units database for Exempt Wells, providing the future distribution of domestic pumping.

The Exempt Well database has over 10,000 wells, the number of actual wells was reduced by grouping all exempt wells listed per section into a single combined pumping location. The number of wells per section was then multiplied by the use rate from the Department's Third Management Plan. The number of wells was further reduced by removing combined demands that were below 1 acre-foot af/yr. The result was 848 aggregate domestic "wells" in the model with a total projected demand of 3,857 af/yr. The location of the domestic demand is scattered across the entire study area.

3.1.4 Other Pumping Demands

Other types of pumping that are included in the projections are non-irrigation grandfathered rights and groundwater withdrawal authorities not associated with agricultural pumping. The reported volumes and distribution for these other pumping demands were obtained from the Department's RoGR database for the year 2007 and were held constant for the entire projection period. The wells with the following right types were exceptions, Temporary Dewatering Permits and Type I and Type II non-irrigation grandfathered rights (Type I & Type II) pumping that was done by the Applicants. The reported volume of pumping under Temporary Dewatering Permits (6,021 af/yr for the year 2007) was removed from the projections given that they are temporary permits therefore they would not be appropriate for a 100-year projection.

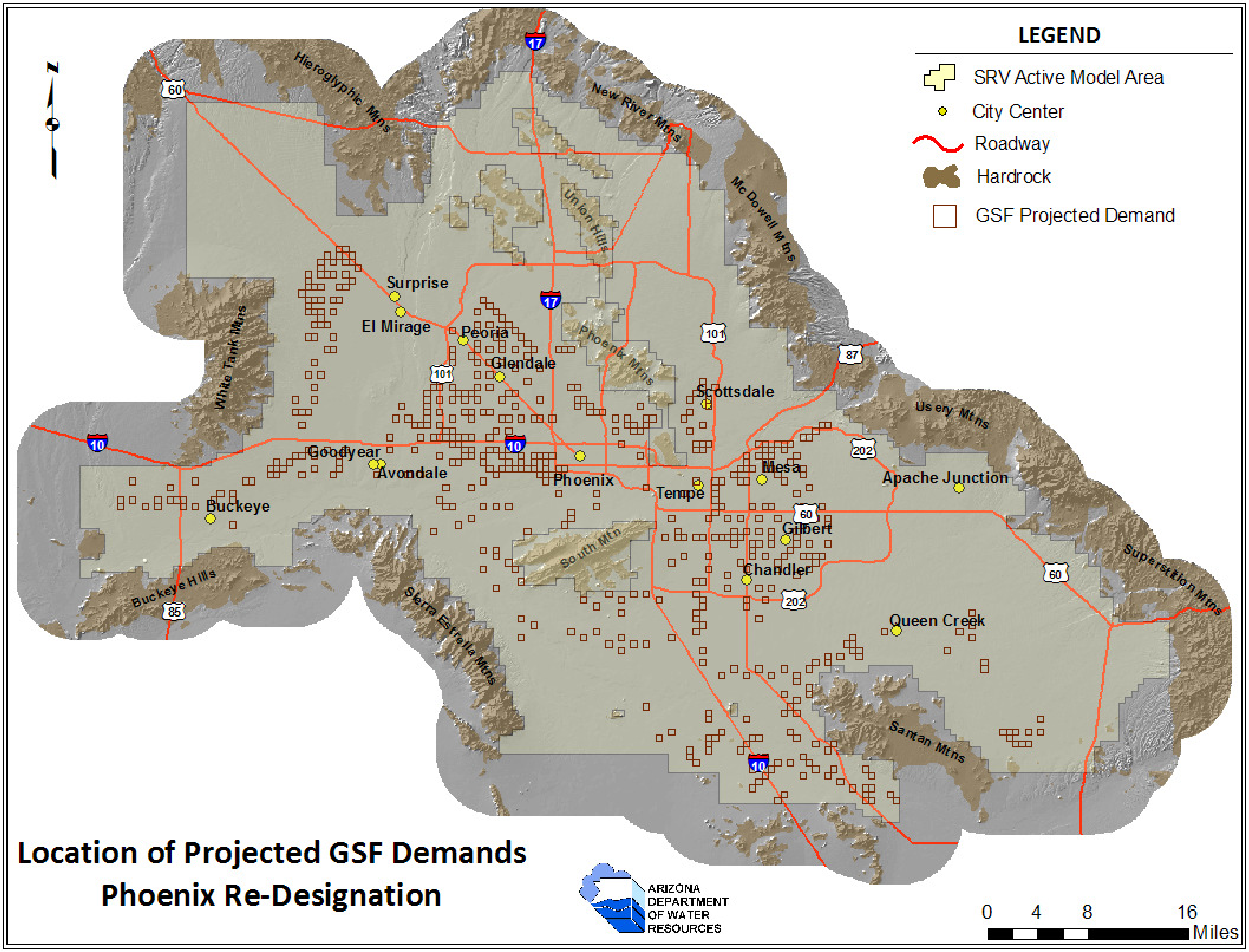


Figure 6. GSF Increase Agricultural Demand Distribution.

The Type I & II pumping that was reported by the Applicants for municipal purposes in the year 2007 was removed since it would be included in the projected demand.

Pumping that occurs on Indian reservations is problematic to project since Indian nations are not required to report their pumping, making it difficult to discern long-term trends. For this study, the volumes and distributions used for the year 2006 in the Departments SRV 1983-2006 model were held constant for the projection period. Table 2 shows the volumes that were held constant for the 100-year projections. Figure 7 shows the distribution of Type I and Type II wells, other Industrial Demands, and Indian related demands.

Table 2. Projected "Other" Pumping Volumes.

	Af/yr
Industrial (Right Type 59)	91,582
Type I & II	35,545
Indian	88,063
TOTAL	**179,645**

3.1.5 CAGRD Replenishment Recharge

The Central Arizona Groundwater Replenishment District (CAGRD) is an entity that was established to replenish (through artificial recharge methods) water to replace groundwater that is pumped for AWS purposes by participating members of the program. The CAGRD uses USFs and GSFs to replenish water throughout the Phoenix AMA. When developing the predictive scenarios the Department took into account that CAGRD replenishment that would be occurring into the future. The projected CAGRD replenishment volumes used in the scenarios were taken from the Department's master water budget Template for the Phoenix AMA Assessment. The Assessment assumed increases in the volume of replenishment based on determinations of AWS with CAGRD contracts. Projected yearly volumes that were calculated for the Assessment were used for all of the scenarios. Table 3 shows representative yearly volumes used for CAGRD replenishment. The volume of CAGRD replenishment for the year 2025 was held constant for the remaining 100-year projection.

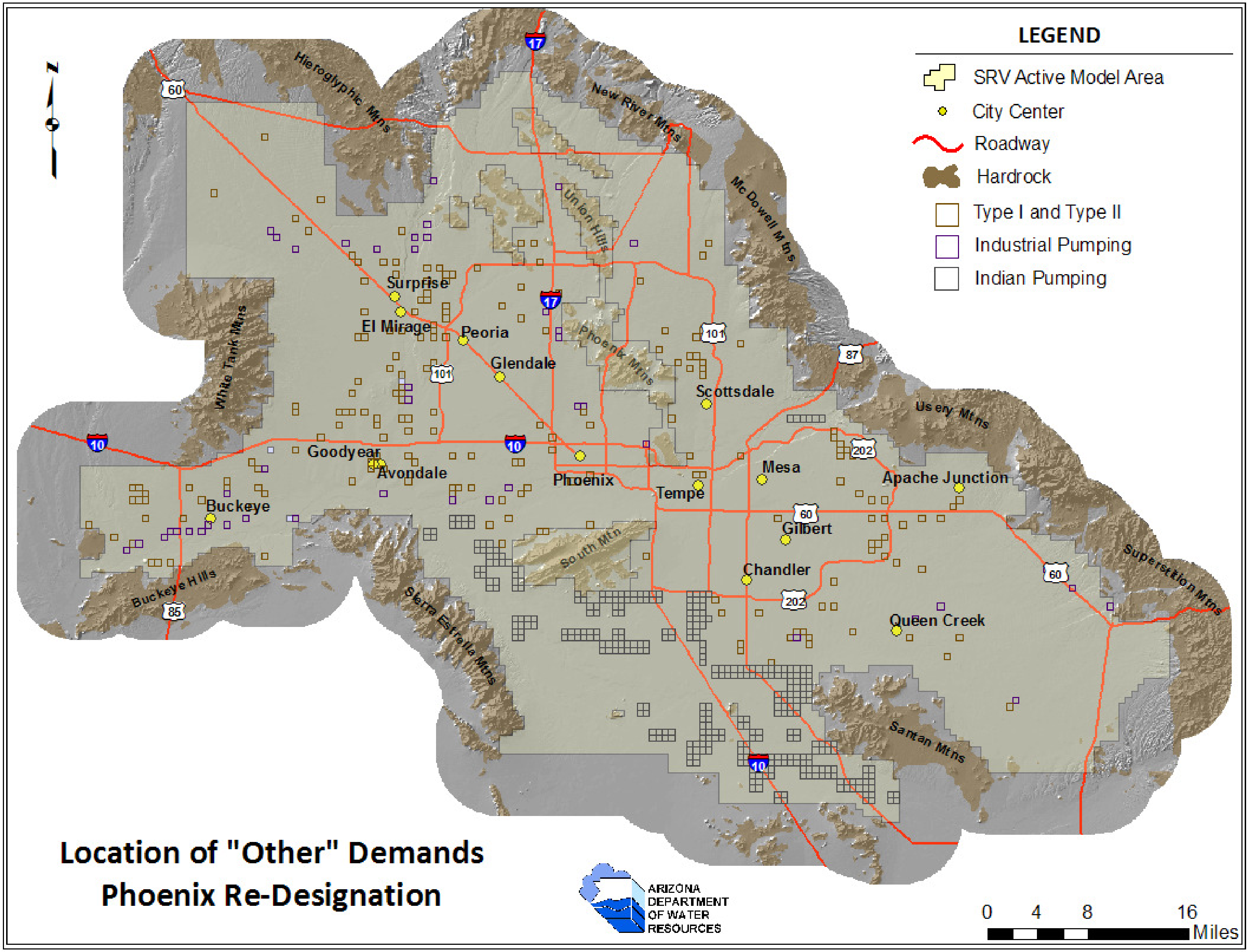


Figure 7. "Other" Demands include Type I and Type II, Industrial, and Indian.

Distribution of this replenishment was based on an average of where CAGRD replenishment has occurred over the past five years (Figure 8). The initial breakdown of where the replenishment occurred had to be adjusted slightly to account for permit limitations at the listed storage facilities. Recharge at the Tonopah Irrigation District and at the Tonopah Desert Recharge Project was not included in the model simulations as these facilities are located outside of the SRV model area.

Table 3. Projected CAGRD Replenishment
(acre-feet/year)

Facility	%	2008	2010	2015	2020	2025
Agua Fria- Constructed	26	10,273	12,273	17,604	29,329	35,555
Agua Fria-Managed	23.4	9,212	11,005	15,786	26,300	31,882
Hieroglyphic	19.6	7,748	9,257	11,716	22,121	26,816
Queen Creek ID	17.3	6,837	8,168	13,277	19,519	23,662
Tonopah ID*	11.3	4,438	5,302	7,605	12,671	15,361
Tonopah Desert Recharge Project*	2.4	947	1,131	1,622	2,703	3,277
TOTAL		**39,455**	**47,136**	**67,610**	**112,643**	**136,553**

* This facility is outside of the study area in the Hassayampa Basin.

3.1.6 Agricultural Recharge

Agricultural Recharge is a major component of the water budget for the Phoenix AMA. Therefore it is a key consideration when developing predicative scenarios. When an agricultural field urbanizes not only does the pumping stop but the associated agricultural recharge also comes to an end. The projected agricultural recharge was determined using the volume and distribution of agricultural recharge for the year 2006 in the SRV Model. The same methodology used for urbanizing agricultural pumping (section 3.1.2) was used for urbanizing agricultural recharge. For any model cell that urbanized in a five-year period, the agricultural recharge was removed from that cell for future time periods. This method was used to determine the agricultural recharge for the predictive period from 2008 through 2025. Representative years of projected Agricultural Recharge volumes are shown in Table 4. After the year 2025 the agricultural recharge was held constant through the year 2108.

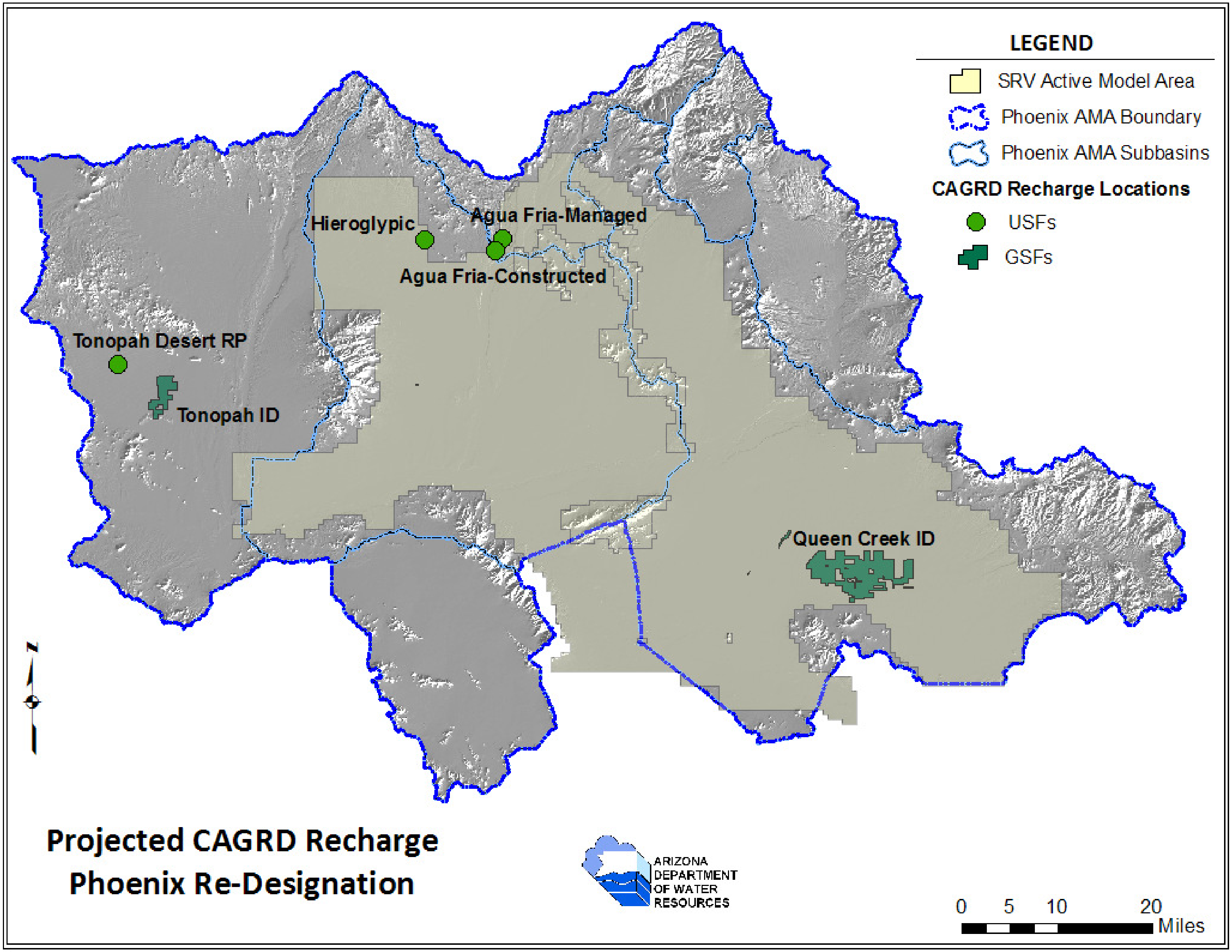


Figure 8. Location of Projected CAGRD Recharge.

Figure 9 shows the historic agricultural recharge in the SRV Model (1984 to 2006) and the projected volumes up to the year 2025. The distribution of agricultural recharge (for the year 2025) is shown in Figure 10. The historic trend in reduced agricultural recharge from 1983 to 2007 reflects the overall reduction in agriculture during that period. Some of the annual variability during that time period reflects annual changes in agricultural water use and differences in the methodologies used to estimate this recharge.

Table 4. Projected Agricultural Recharge Volumes
(acre-feet/year)

2008	2010	2015	2020	2025
486,279	476,357	425,645	389,651	341,656

3.1.7 Other Incidental Recharge

For the projection period other categories of incidental recharge were held constant at the volumes based on 2006 water use and assumed incidental recharge rates that were applied in the SRV Model (Freihoefer et.al., 2009). Projected incidental recharge for perennial reaches of the Salt River, Gila River and the Buckeye Irrigation Canal (BIC) were based on head dependant fluxes simulated by the MODFLOW stream-flow routing package. The following table is a breakdown of the various recharge rates used for the predictive scenarios (Table 5).

Table 5. Other Incidental Recharge Volumes

Type of Recharge	Af/yr
Mountain Front	19,308
Major Ephemeral Rivers and Streams	49,707
Lake	13,580
Urban	32,767
Turf	19,697
Canal	101,005
TOTAL	**236,064**

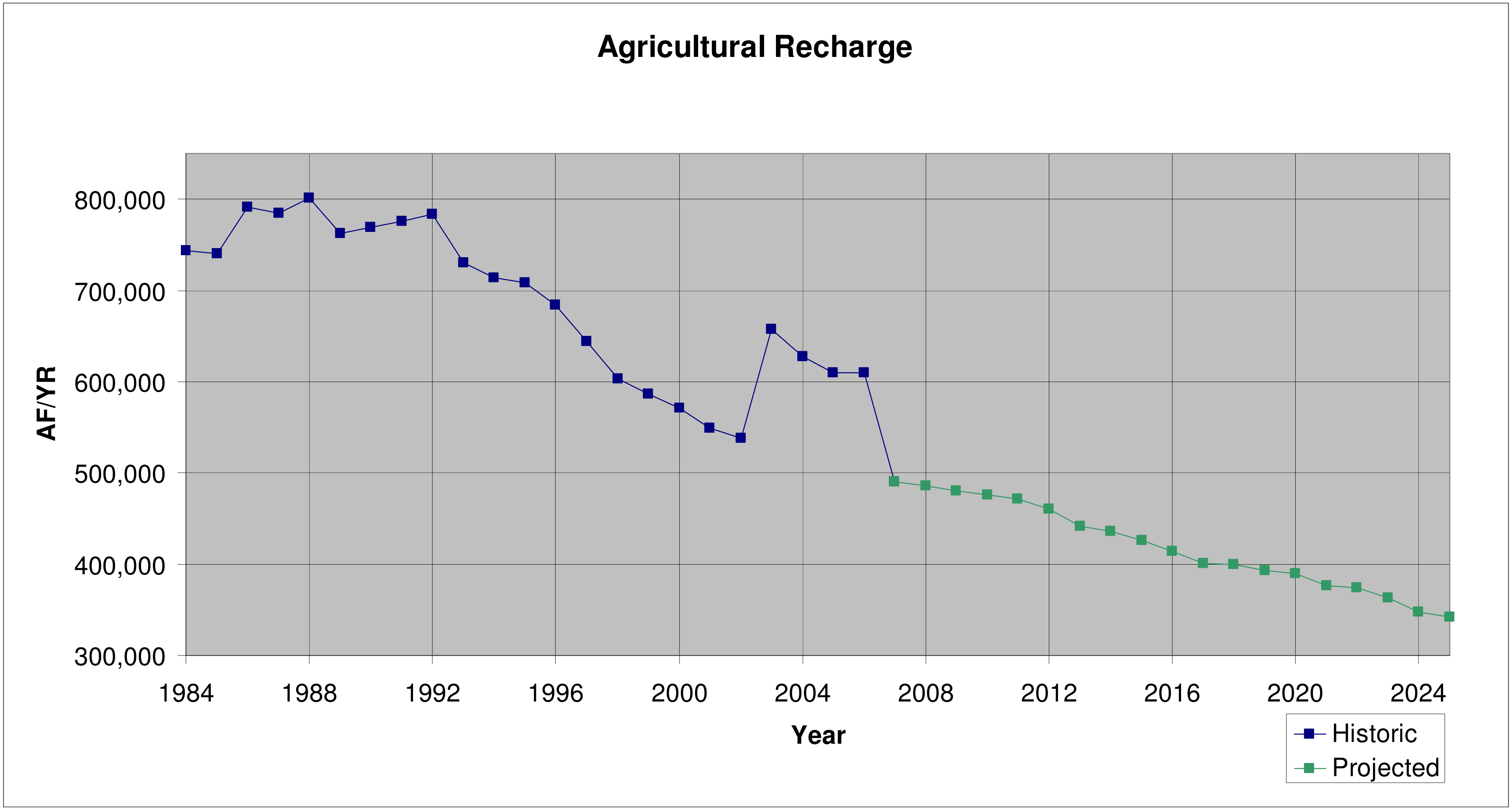


Figure 9. Volume of Agricultural Recharge, Historic and Projected.

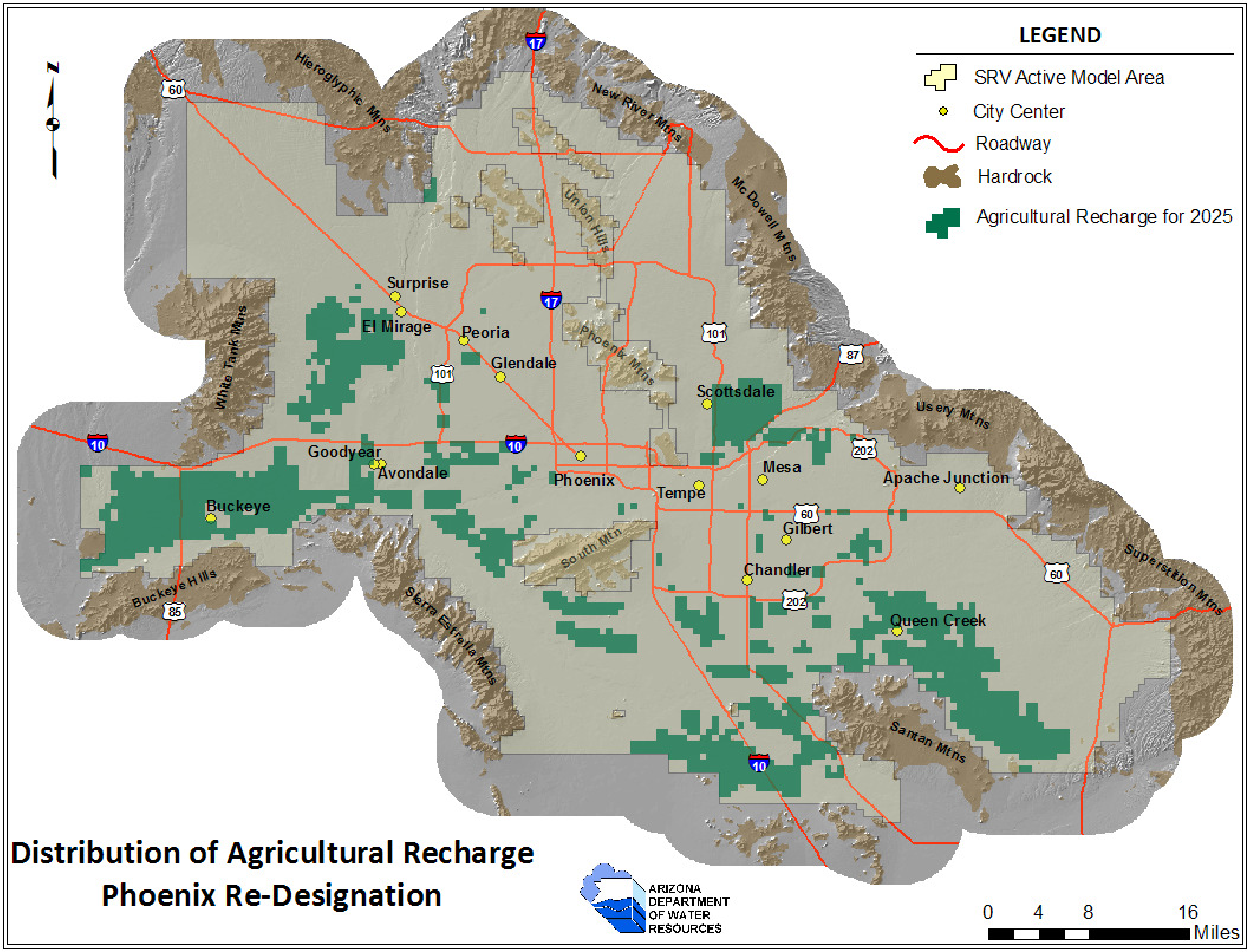


Figure 10. Projected Distribution of Agricultural Recharge for the year 2025.

3.1.8 Predictive Model Boundary Conditions

Most of the model boundary conditions were not changed from those used in the SRV Model. These values were held constant for the 100-year projection. The western edge of the SRV Model is the major exception. Directly to the west of the study area is the Hassayampa subbasin. During the time period from 2005 through 2008 the Hassayampa subbasin experienced a dramatic increase in the volume of Issued AWS Demands.

The Hassayampa subbasin was modeled by Brown and Caldwell (Brown and Caldwell, 2006) through a joint agreement between developers in the Hassayampa Basin, the Town of Buckeye, and the Department. Out of the numerous predictive scenarios that were run using this model the Department determined that Scenario 10 best reflected the requirements of the AWS Rules. Using the Hassayampa mode outputs, the projected boundary conditions along the western margins of the SRV model were modified to account for Issued AWS demands in the Hassayampa subbasin and subsequent groundwater level declines. The western edge of the SRV model was altered through the 100-year projection period using time-varying constant head model cells to reflect the results from the Hassayampa Model's Scenario 10.

3.2 Scenario Assumptions

The scenarios assumptions cover the changes that vary per scenario. For the most part these assumptions entail changes in the Applicants' pumping demands and recharge volumes that are associated with the re-Designation process. These assumptions also include changes in other values that are directly connected to the Applicants' pumping and recharge volumes. Some assumptions remain constant through the different scenarios such has how the volumes of recharge and pumping are distributed and how certain volumes are calculated. All assumptions and their associated volumes remain constant after the year 2025 through 2108.

3.2.1 Pumping Distribution

The Applicants and SRP provided the well locations and volumes for the initial scenario. The initial pumping volumes were also broken down to groundwater pumping and recovery of LTSCs. The Water Storage Permit number was also provided for the recovery pumping thus assisting in determining at what recharge facility the credits had been accrued at. The distribution of various volumes of groundwater pumping and recovery pumping for an applicant was based on the proportions of these original submittals. The overall general distribution of municipal pumping from the various Applicants is shown in Figure 11. Some of the pumping locations submitted are outside of the study area. These volumes were not included in the modeling results. The locations of SRP pumping provided by SRP for the projection period are shown in Figure 12. As with the Applicant pumping, changes in SRP projected pumping was distributed proportionately by well based on what SRP originally submitted.

3.2.2 LTSC Withdrawals

Under the Department's Recharge Program entities are able to earn LTSCs at permitted recharge facilities. There are two types of facilities, Underground Storage Facilities (USF) and Groundwater Savings Facilities (GSFs). When determining physical availability for an AWS application, the LTSCs earned by other entities (e.g., the Arizona Water Banking Authority) must be removed since this volume of water is assumed not to be available to the applicant in the future.

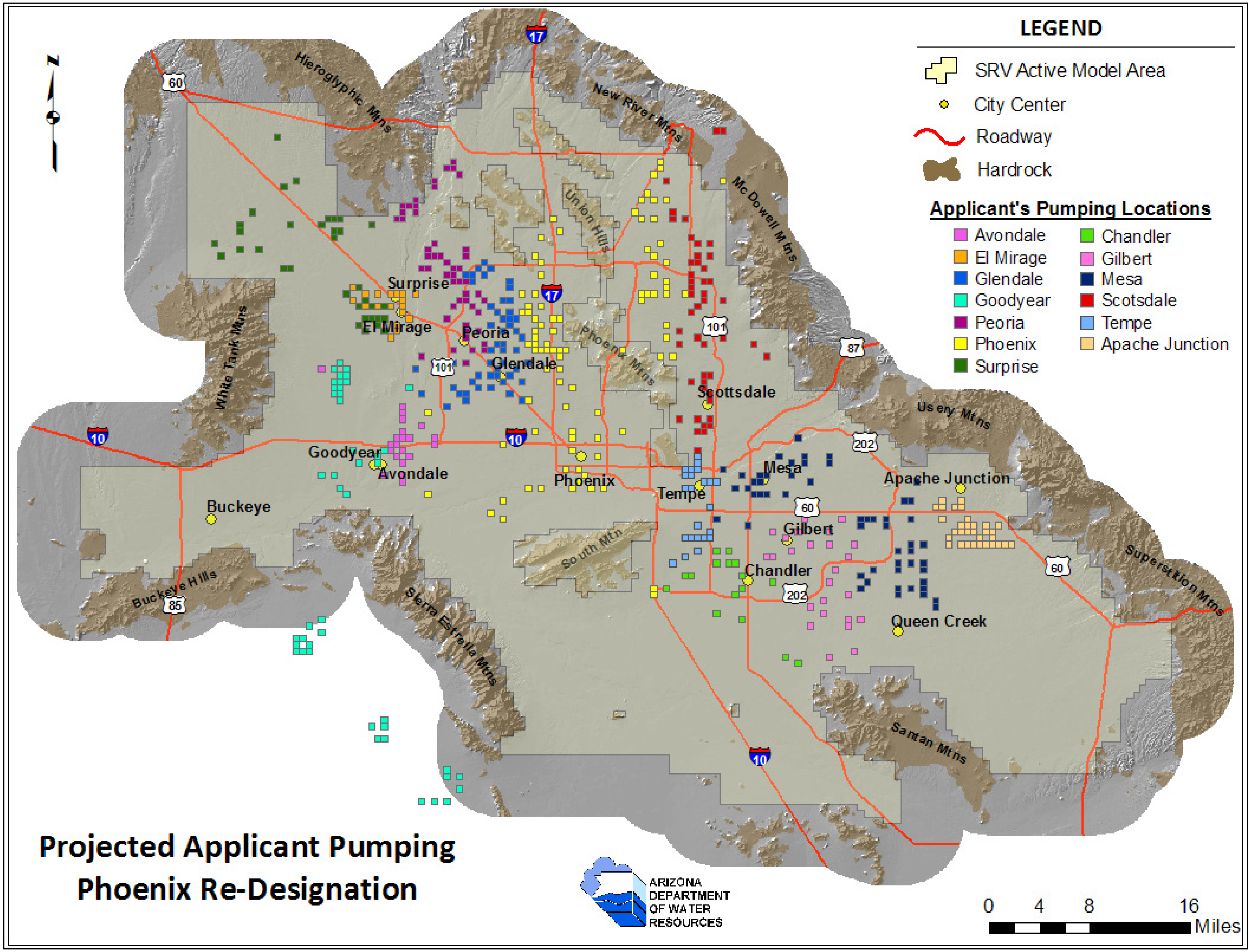


Figure 11. Projected Distribution of Applicant Municipal Pumping.

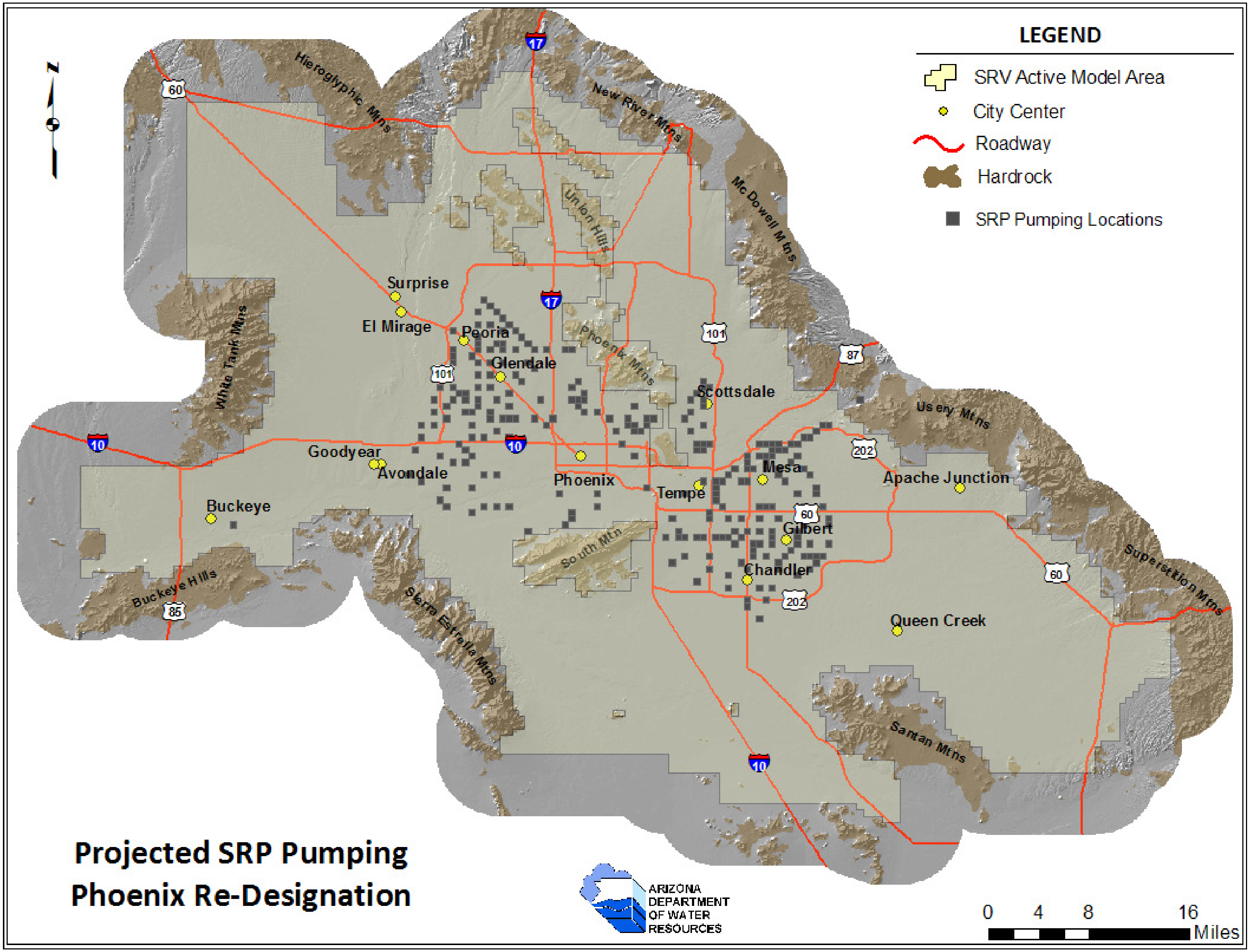


Figure 12. Projected Distribution of SRP Pumping.

Therefore, the volume of LTSCs that was not used to meet the Applicant's demands had to be removed from the model.

The LTSCs were summed by facility through the year 2007. The LTSCs that were stored at a facility were decreased by any projected recovery by the Applicants. If there were LTSCs remaining the volume are divided by 100-years to determine the yearly volume of pumping required to remove the LTSCs from the model over the projection period. This yearly volume was then distributed to existing and/or hypothetical wells within the areas of the recharge facility where the LTSCs were stored (Figure 13). For the USFs hypothetical wells were located in the model cells used to simulate the recharge in the SRV Model. In the case of the GSFs the removal of the unused LTSCs was accomplished using wells located within the facility boundaries. As described previously, the volume of groundwater that was stored to replenish groundwater through the CAGRD was not removed.

3.2.3 Projected Artificial Recharge

Under AWS Rules an applicant can use their projected recharge when determining physical availability, as long as it is at a permitted facility. The Applicants provided recharge volumes and locations for their projected recharge. For most scenarios changes concerning artificial recharge used the same proportions as the Applicants originally provided to determine the new distribution of artificial recharge volumes. For some scenarios the proportions for a specific Applicant had to be adjusted when a recharge facility's maximum permitted volume was exceeded.

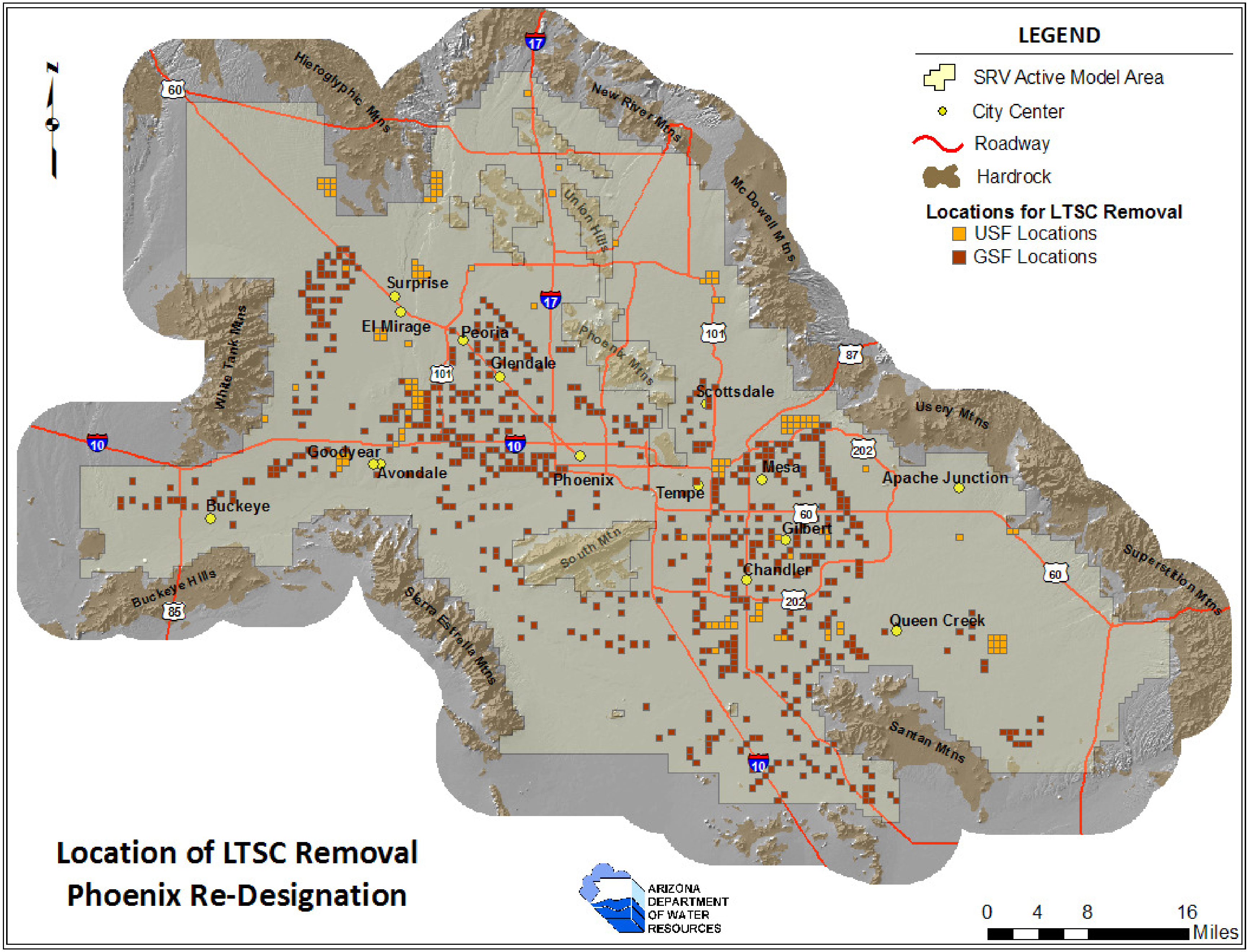


Figure 13. Locations for removing LTSCs in the Study Area.

4.0 Scenario 1 – Applicants Scenario

The first scenario incorporated all of the previously described Modeling Assumptions and used the pumping and recharge volumes provided by the Applicants and SRP. The Applicants provided yearly volumes broken down by well, type of pumping (i.e. groundwater or recovery) plus location and type of water recharged. The pumping and recharge volumes reflected in Scenario 1 represent the data submitted by May 15, 2009

4.1 Pumping – Applicants Scenario 1

The following tables (Table 7 and Table 8) provide a sampling of the yearly pumping volumes supplied by the various entities. The two tables divide the Applicants into East Salt River Valley sub-basin (ESRV) and West Salt River Valley sub-basin (WSRV) depending on which sub-basin contained the bulk of their water service area. Figure 14 shows the historical pumping from the Applicants and the projected pumping for Scenario 1 through the year 2025.

4.2 Pumping – SRP Scenario 1

The SRP also provide projected pumping by well. The projected volume of pumping was a long term average based on SRP's database of historical annual pumping going back to the early 1900's. Unlike the increasing volume of pumping that the Applicants provided, SRP used a constant volume for the projection period. Table 6 gives a breakdown of SRP's projected groundwater and recovery of LTSC pumping. The relationship between the historical pumping from the Department's RoGR database and the projected SRP pumping is shown in Figure 15.

Table 6. Projected SRP Pumping Volumes

	Af/yr
Groundwater	235,920
Recovery	15,405
TOTAL	**251,325**

Table 7. Scenario 1 - Projected Groundwater Demand per Provider in the ESRV.
(acre-feet per year)

Water Provider	Pumping Type	2008	2010	2015	2020	2025
Apache Junction	Groundwater	1,490	1,426	4,697	10,337	13,444
	Recovery	0	0	144	816	1,464
	Total	**1,490**	**1,426**	**4,841**	**11,153**	**14,908**
Chandler	Groundwater	4,010	4,313	5,075	5,838	5,838
	Recovery	22,283	18,962	22,749	34,602	34,602
	Total	**26,293**	**23,275**	**27,824**	**40,440**	**40,440**
Gilbert	Groundwater	6,066	4,842	17,874	21,581	26,662
	Recovery	0	0	0	0	0
	Total	**6,066**	**4,842**	**17,874**	**21,581**	**26,662**
Mesa	Groundwater	5,207	5,115	4,874	4,691	4,514
	Recovery	21,134	23,476	24,049	24,049	24,049
	Total	**26,341**	**28,591**	**28,923**	**28,740**	**28,563**
Scottsdale	Groundwater	18,745	19,086	19,645	20,114	25,883
	Recovery	0	11,500	14,750	16,000	16,100
	Total	**18,745**	**30,586**	**34,395**	**36,114**	**41,983**
Tempe	Groundwater	5,335	5,856	6,098	6,098	6,098
	Recovery	6,235	7,372	7,632	7,632	7,632
	Total	**11,570**	**13,228**	**13,730**	**13,730**	**13,730**
	TOTAL	**90,505**	**101,948**	**127,587**	**151,758**	**166,286**

Table 8. Scenario 1 - Projected Groundwater Demand per Provider in the WSRV
(acre-feet per year)

Water Provider	Pumping Type	2008	2010	2015	2020	2025
Avondale	Groundwater	200	300	300	200	493
	Recovery	17,735	18,862	21,341	23,921	25,563
	Total	**17,935**	**19,162**	**21,641**	**24,121**	**26,056**
El Mirage	Groundwater	9,216	11,052	12,888	17,478	17,478
	Recovery	1,400	2,344	2,534	2,746	2,978
	Total	**10,616**	**13,396**	**15,422**	**20,224**	**20,456**
Glendale	Groundwater	3,964	4,464	5,709	6,954	8,200
	Recovery	2,340	4,854	11,145	17,427	23,719
	Total	**6,304**	**9,318**	**16,854**	**24,381**	**31,919**
Goodyear	Groundwater	9,633	13,217	32,375	58,142	80,034
	Recovery	0	0	0	0	2,420
	Total	**9,633**	**13,217**	**32,375**	**58,142**	**82,454**
Peoria	Groundwater	25	2,417	2,417	2,417	2,417
	Recovery	9,254	49,420	55,420	57,420	57,420
	Total	**9,279**	**51,837**	**57,837**	**59,837**	**59,837**
Phoenix	Groundwater	51,086	51,086	51,086	51,086	51,086
	Recovery	1,209	1,209	1,209	1,209	1,209
	Total	**52,295**	**52,295**	**52,295**	**52,295**	**52,295**
Surprise	Groundwater	5,520	4,959	6,801	7,751	8,023
	Recovery	0	0	0	0	0
	Total	**5,520**	**4,959**	**6,801**	**7,751**	**8,023**
	TOTAL	**111,582**	**164,184**	**203,225**	**246,751**	**281,040**

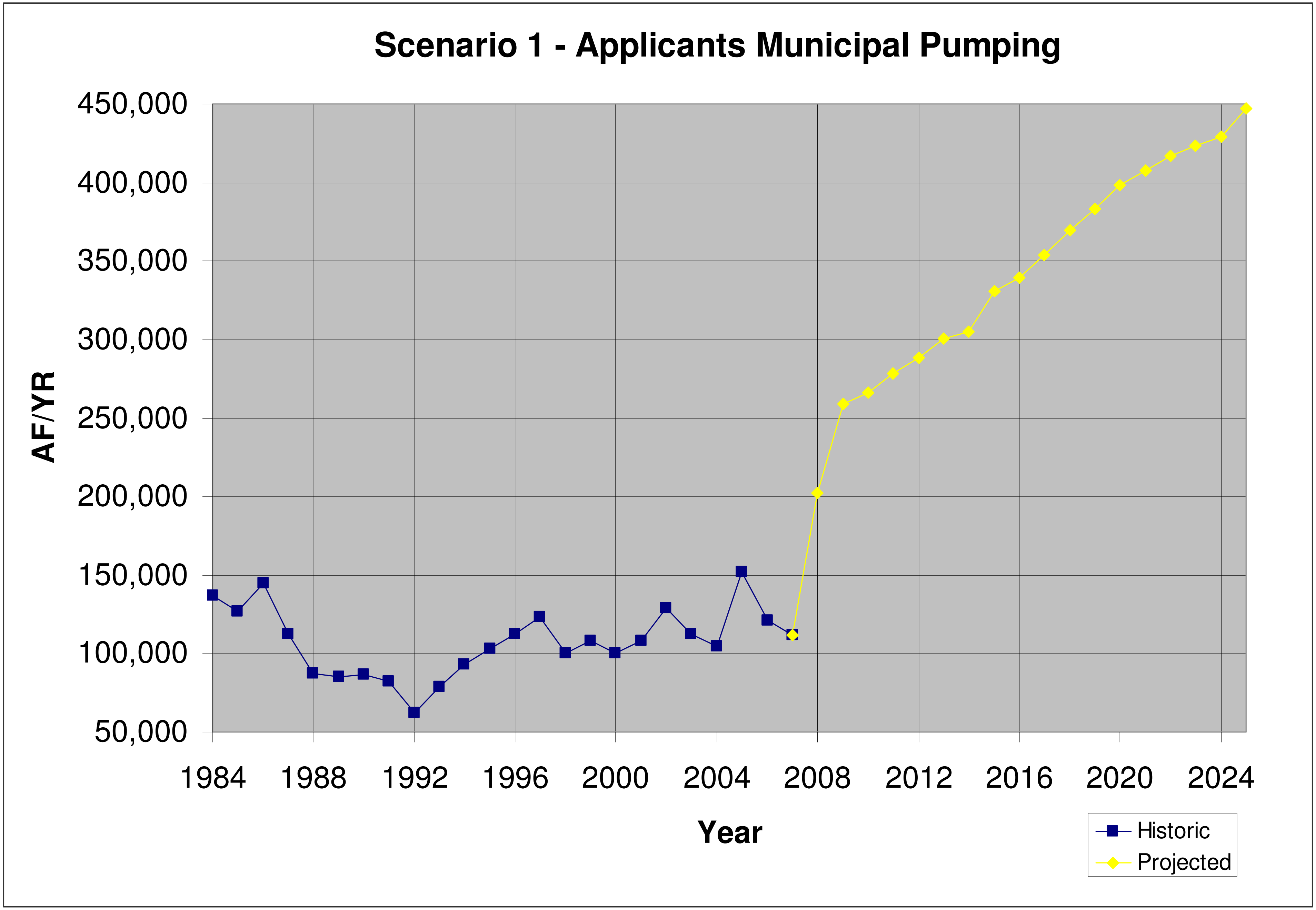


Figure 14. Scenario 1 - Applicants Historic and Projected Municipal pumping.

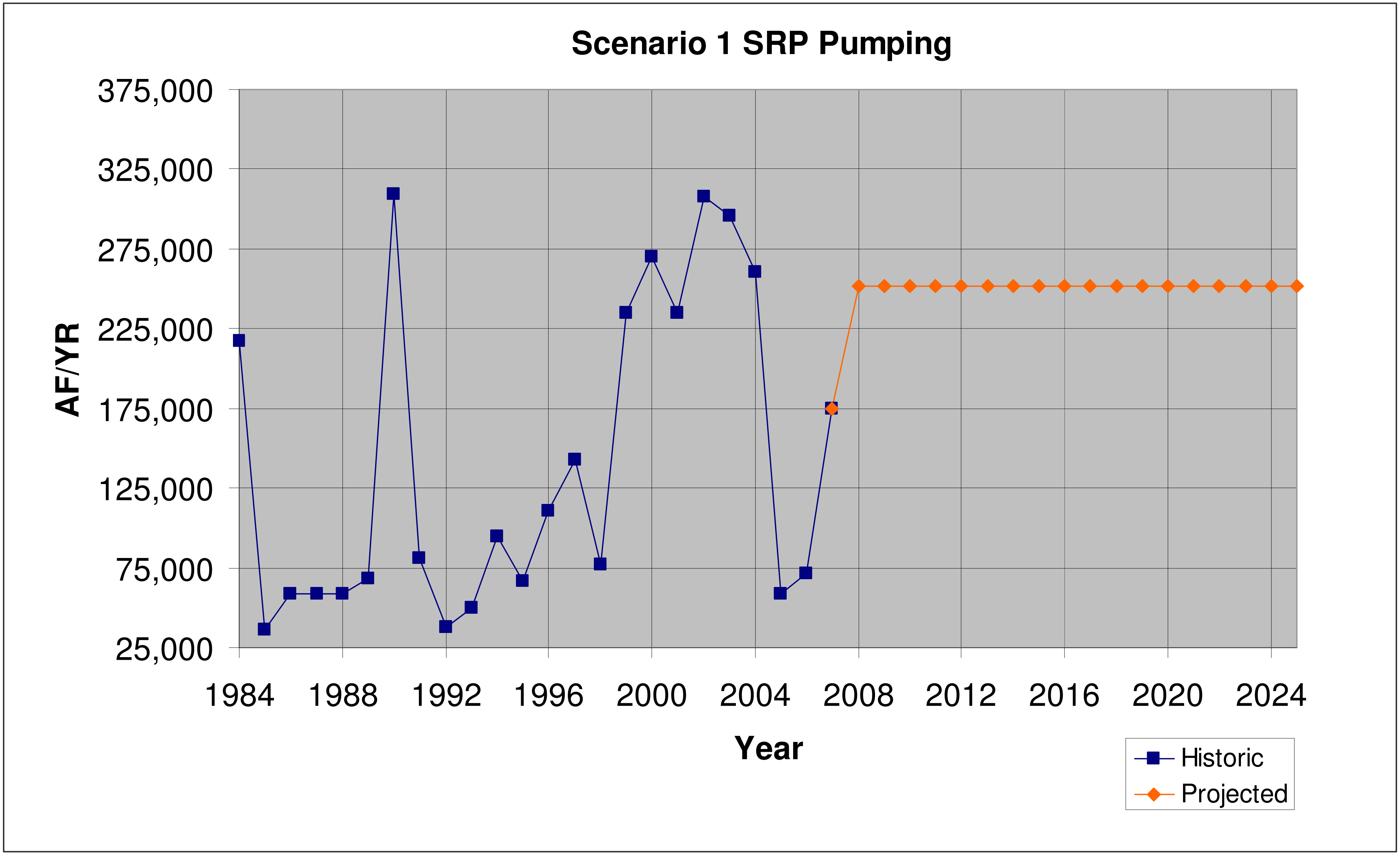


Figure 15. Scenario 1 - Re-Designation SRP Historic and Projected pumping.

4.3 Artificial Recharge – Scenario 1

When determining physical availability for an AWS application an applicant can include the amount that they plan to recharge in the 100-year projection. The applicant must show that they have the legal rights to the volume of water that they want to recharge and the recharging is occurring at a permitted storage facility. Additionally, the total volume of water must not exceed the permitted volume of water for a specific storage facility. The Applicants provided yearly recharge volumes broken down by facility and water type out to the year 2025. The remaining 75 years of the 100-year projection kept the projected artificial recharge volume from the year 2025 constant. Table 9 and 10 show representative years for the yearly recharge volumes provided by the Applicants broken out by sub-basin.

The USF recharge sites the Applicants proposed to recharge at are shown on Figure 16. Figure 16 also illustrates that not all of the recharge sites are located within the study area. The USF recharge outside of the study area was not included in the physical availability determination. Figure 17 shows the relationship between historic USF recharge and projected USF recharge within the study area. The historic volumes represent the total volumes of water recharged at the facilities. This includes the Applicants and all the other entities that stored water at USFs for those time periods. The projected volumes of USF recharge only represent recharge at USFs from the Applicants and the projected recharge at USFs to meet CAGRD obligations (Table 3).

4.4 Modeling Adjustments to Pumping Scenario 1

All the assumptions were incorporated into the scenario and the model was run out to the year 2108. In MODFLOW the pumping in a model cell is combined and distributed between the layers simulated in the model (in this case three layers). If the simulated water level elevation in a model cell goes below the bottom elevation of a layer that portion of the model cell goes dry (sometime referred to as a “dewatered” cell). Any pumping that is simulated coming from that portion of the model cell is no longer included (since there is no water to pump) in the simulation. For Scenario 1 there was a significant amount of pumping that was not simulated in the scenario by the year 2108.

Table 9. Scenario 1 - Projected USF Recharge per Provider in the WSRV
(acre-feet per year)

Applicant	Recharge Facility	USF No.	2008	2010	2015	2020	2025
Avondale	Agua Fria (Const.)	71-569776	500	500	500	500	500
	Agua Fria (Mang.)	71-569775	1,500	1,500	1,000	1,000	1,000
	Avondale Wetlands	71-565257	7,800	15,000	15,000	15,000	15,000
	Hieroglyphic Mt.	71-584466	8,416	8,416	3,916	3,916	3,916
	NAUSP	71-588558	0	812	3,199	5,587	7,731
		Total	**18,216**	**26,228**	**23,615**	**26,003**	**28,147**
El Mirage	El Mirage Const.	71-211282	1,400	2,240	2,800	3,360	4,032
	Tonopah Desert	71-593305	508	508	508	508	508
		Total	**1,908**	**2,748**	**3,308**	**3,868**	**4,540**
Glendale	Arrowhead	71-591934	504	504	504	504	504
	Glendale ARF	71-586730	8,482	0	2,882	6,800	10,800
	NAUSP	71-588558	9,431	14,456	14,973	14,972	14,930
		Total	**18,417**	**14,960**	**18,359**	**22,276**	**26,234**
Goodyear	NAUSP	71-588558	0	0	7,000	3,500	0
	Goodyear SAT	71-566367	1,100	0	0	0	0
	Hieroglyphic Mt.	71-584466	0	0	7,000	3,500	0
		Total	**1,100**	**0**	**14,000**	**7,000**	**0**
Peoria	Agua Fria (Const.)	71-569776	4,862	9,000	9,000	9,000	9,000
	Agua Fria (Mang.)	71-569775	4,862	9,000	9,000	9,000	9,000
	Beardsley	71-552497	4,000	4,480	13,441	13,441	17,920
	Hieroglyphic Mt.	71-584466	1,312	6,000	10,000	10,000	10,000
	NAUSP	71-588558	3,650	21,269	24,566	24,566	24,566
		Total	**18,686**	**49,749**	**66,007**	**66,007**	**70,486**
Phoenix	Cave Creek	71595199	2,000	2,000	2,000	2,000	2,000
	GRUSP	71-516371	0	5,000	5,000	5,000	5,000
		Total	**2,000**	**7,000**	**7,000**	**7,000**	**7,000**
Surprise	Agua Fria (Const.)	71-569776	0	0	10,249	0	0
	Surprise WWTP	71-562521	8,066	8,066	8,066	8,066	8,066
	Hieroglyphic Mt.	71-584466	10,249	0	0	10,249	0
	Tonopah Desert	71-593305	**0**	10,249	**0**	**0**	10,249
		Total	**18,315**	**18,315**	**18,3150**	**18,315**	**18,315**
		TOTAL	**78,642**	**119,000**	**150,604**	**150,469**	**154,722**

Table 10. Scenario 1 - Projected USF Recharge per Provider in the ESRV
(acre-feet per year)

Applicant	Recharge Facility	USF No.	2008	2010	2015	2020	2025
Apache Junction		**Total**	**0**	**0**	**0**	**0**	**0**
Chandler	GRUSP	71-516371	20,000	20,000	20,000	20,000	20,000
		Total	**20,000**	**20,000**	**20,000**	**20,000**	**20,000**
Gilbert	Agua Fria (Const.)	71-5569776	5,000	5,000	5,000	5,000	5,000
	Neely Wildlife	71-520379	896	896	896	896	896
	GRUSP	71-516371	0	1,000	1,000	1,000	1,000
	Municipal ASR	71-591935	1,000	1,000	1,000	1,000	1,000
	Gilbert South	71-595198	4,421	3,227	3,891	5,591	5,138
	Tonopah Desert	71-593305	20,000	20,000	20,000	20,000	20,000
	Riparian Preserve	71-5564416	4,000	4,000	4,000	4,000	4,000
		Total	**35,317**	**35,123**	**35,787**	**37,487**	**37,034**
Mesa	GRUSP	71-516371	12,958	12,098	12,083	14,114	14,114
		Total	**12,958**	**12,098**	**12,083**	**14,114**	**14,114**
Scottsdale	West World	71-574911	500	1,000	1,000	1,000	1,000
	N. Scottsdale ASR	71-583022	1,000	1,400	1,400	1,400	1,400
	Water Campus	71-560648	3,330	9,100	12,350	13,600	13,700
		Total	**4,830**	**11,500**	**14,750**	**16,000**	**16,100**
Tempe	Kyrene	71-563943	0	3,400	3,400	3,400	3,400
	GRUSP	71-516371	500	2,350	2,350	2,350	2,350
		Total	**11,570**	**13,228**	**13,730**	**13,730**	**13,730**
		TOTAL	**73,605**	**84,471**	**89,090**	**93,351**	**92,998**

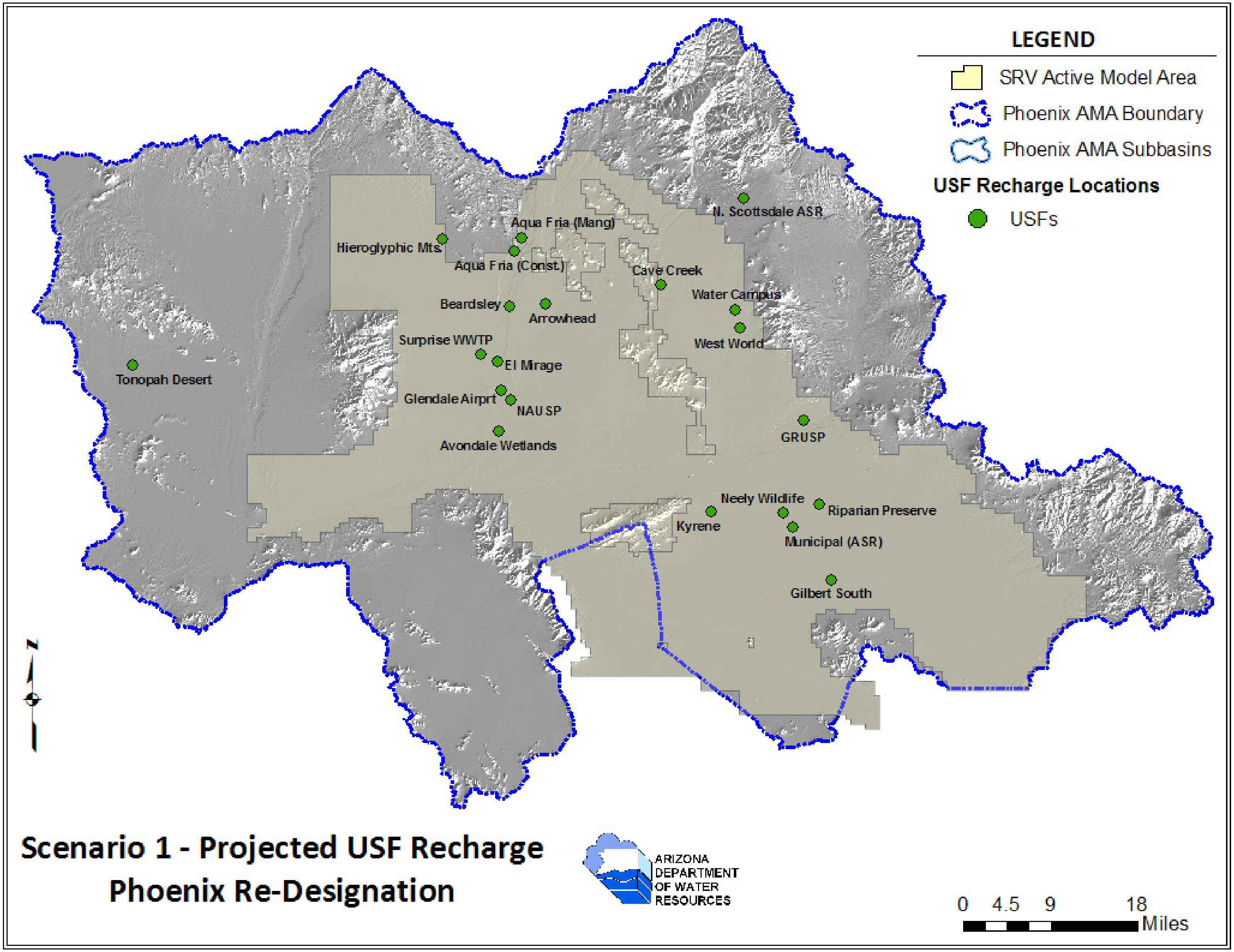


Figure 16. Scenario 1 - Location of Projected USF Recharge.

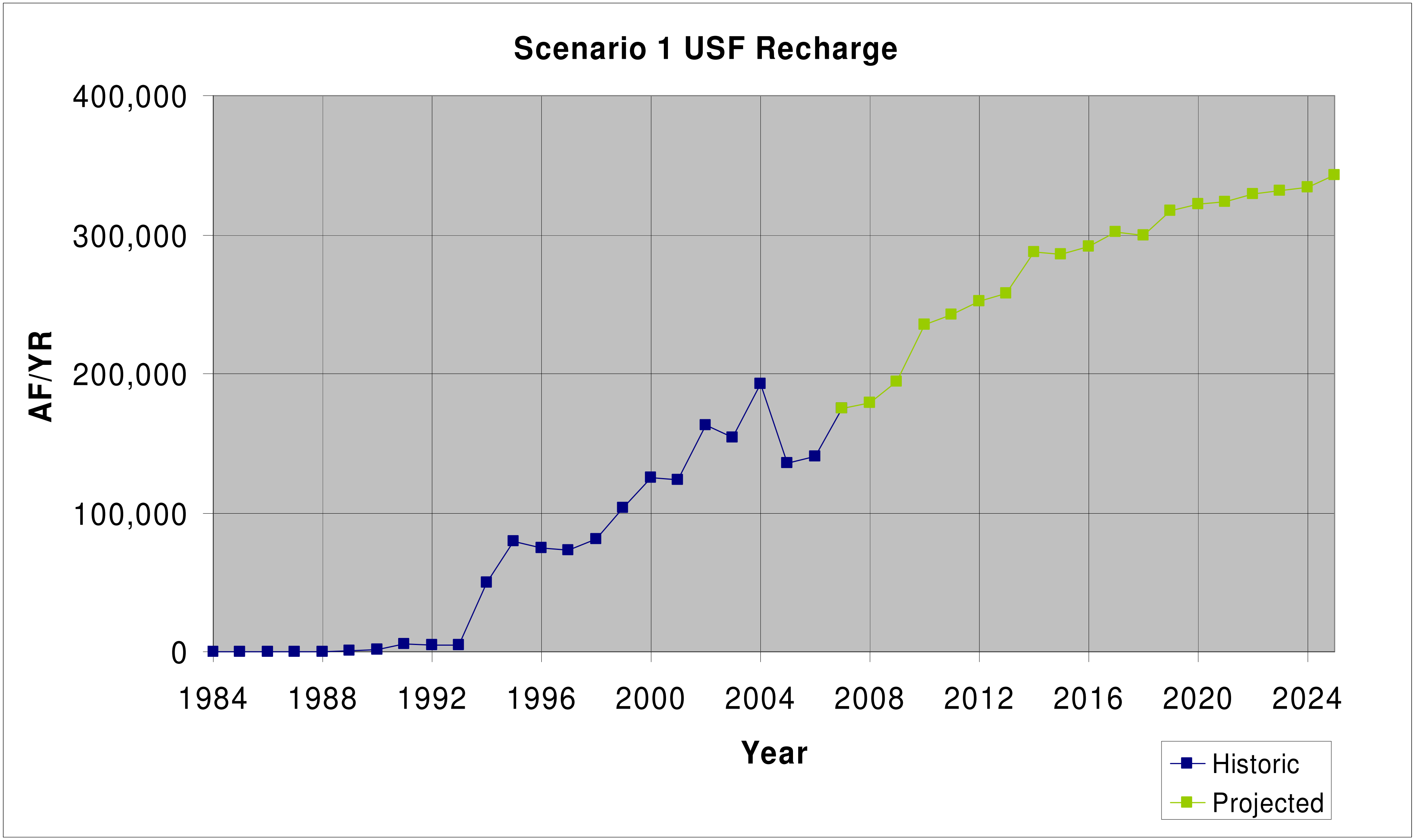


Figure 17. Scenario 1 - USF Recharge, Historic and Projected within the Study Area.

Of special interest are the issued AWS demands and the Applicants' pumping (henceforth the combined pumping will be referred to as AWS pumping) that were in dry model cells. In an attempt to have more of the AWS pumping in the simulation the pumping in dry model cells that contained AWS pumping was re-distributed to surrounding cells. This did increase the AWS pumping simulated, however, there was still projected AWS pumping that could not be simulated in the model run. Overall a total of 12,238,938 acre-feet of pumping (all types of pumping) was not simulated for the projection period, 2008 to 2108.

4.5 Results – Scenario 1

The results from Scenario 1 are shown in Figure 18. Figure 18 represents the projected depth to water (DTW) of Layer 3 for the year 2108. Layer 3 provides the most comprehensive look of the results since there are numerous model cells that go dry in Layers 1 and 2. The bright red areas on the map represent areas 1,000 feet bls. Model cells that went dry in Layer 3 are shown by a dark brown color. The dry cell areas generally are located around the edge of the model where the overall saturated thickness of the aquifer is thinner. When there is a group of dry cells it is commonly a combination of a thinner aquifer and areas with significant pumping. Overall a significant amount of AWS demand that was simulated did not meet the physical availability criteria of the DTW for AWS pumping being above 1,000 feet bls.

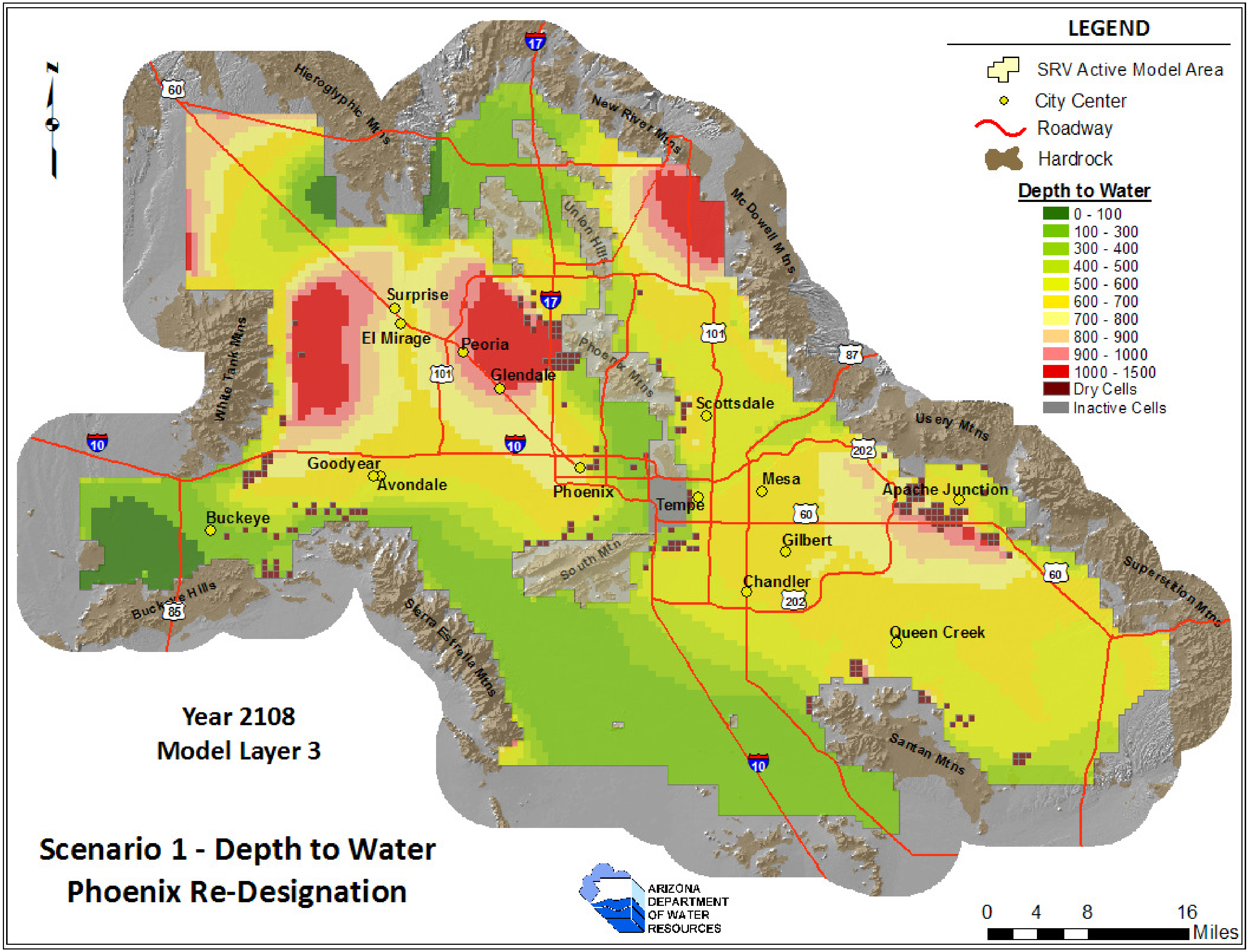


Figure 18. Scenario 1 - Depth to Water (DTW) of Layer 3 for the year 2108.

5.0 Scenario 2 – Direct Surface Water Use, 2025 Demands

After viewing the results from Scenario 1 the Department attempted to develop a scenario that would come closer to meeting the physical availability criteria for the AWS determination. The second scenario used a pumping scenario that represented the Applicants' direct use of their surface water (calculated as eighty percent of their treatment capacity for available surface water) to meet their demand out to the year 2025. The recharge volumes assumed for Scenario 1 were reduced to reflect more surface water being used directly, therefore less water was available for recharge. The volume of SRP pumping was also reduced to reflect an average based on reported volumes from 1984 to 2007. All of the previously assumptions described in the Modeling Assumptions section were incorporated into Scenario 2.

5.1 Pumping – Applicants Scenario 2

A total volume of AWS pumping was calculated, per Applicant, to reflect direct use of their surface water. The volumes calculated were based on the Applicant's projected demands for the year 2025. These volumes were held constant between the years 2008 to 2108. The groundwater pumping was distributed to the same wells the Applicant provided for Scenario 1. The volumes distributed were proportionately equivalent to the pumping distribution used for Scenario 1 for each of the projection years from 2008 to 2025. Table 11 provides the groundwater and recovery volumes used for the Applicants for the year 2025. Only projected volumes for the year 2025 are shown since they are representative of the entire projection period. The Applicants are roughly split into ESRV and WSRV depending on which subbasin the bulk of their service area is located. Figure 19 shows the historical municipal pumping from these providers and the projected pumping for Scenario 2 through the year 2025.

Table 11. Scenario 2 - Projected Groundwater Demand per Provider
(acre-feet per year)

ESRV

Water Provider	Pumping Type	2025
Apache Junction	Groundwater	14,279
	Recovery	383
	Total	**14,662**
Chandler	Groundwater	10,201
	Recovery	22,319
	Total	**32,520**
Gilbert	Groundwater	26,657
	Recovery	0
	Total	**26,657**
Mesa	Groundwater	16,127
	Recovery	11,937
	Total	**28,064**
Scottsdale	Groundwater	13,927
	Recovery	5,431
	Total	**19,358**
Tempe	Groundwater	6,975
	Recovery	4,076
	Total	**11,051**
	TOTAL	**132,325**

WSRV

Water Provider	Pumping Type	2025
Avondale	Groundwater	1,700
	Recovery	24,354
	Total	**26,054**
El Mirage	Groundwater	5,940
	Recovery	4,541
	Total	**10,481**
Glendale	Groundwater	7,525
	Recovery	5,595
	Total	**13,120**
Goodyear	Groundwater	30,655
	Recovery	0
	Total	**30,655**
Peoria	Groundwater	3,000
	Recovery	6,200
	Total	**9,200**
Phoenix	Groundwater	39,742
	Recovery	4,102
	Total	**43,844**
Surprise	Groundwater	20,926
	Recovery	0
	Total	**20,926**
	TOTAL	**154,280**

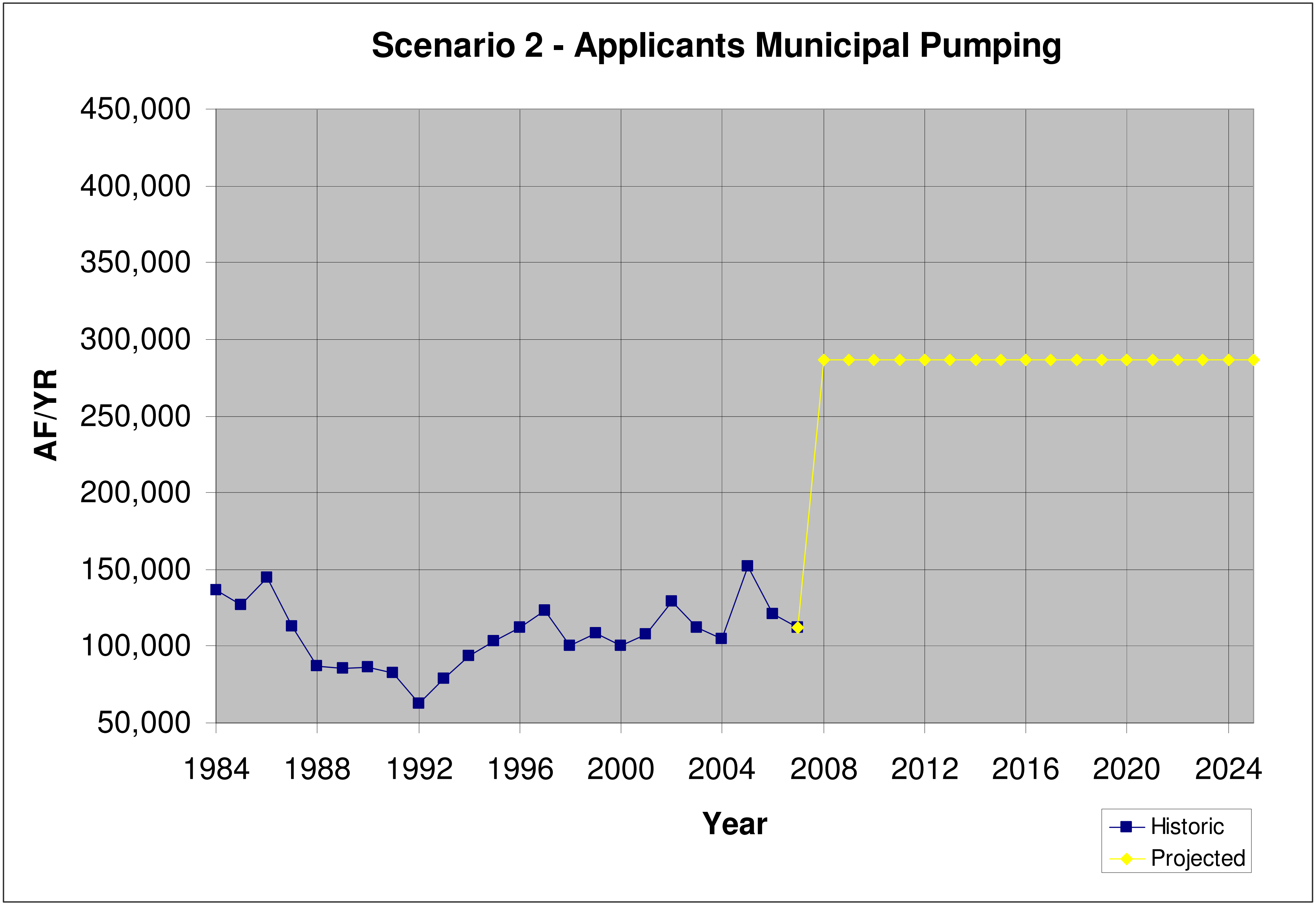


Figure 19. Scenario 2 - Applicants Historic and Projected Municipal pumping.

5.2 Pumping – SRP Scenario 2

Instead of using the long term average provided by SRP a shorter term average from 1984 to 2007 was used. This average was based on annual volumes of pumping reported to the Department by SRP. The same wells provided by SRP were used to distribute the reduced pumping. The volume of water pumped from the wells was reduced proportionately to reflect the reduced volume. The amount of projected recovery provided by SRP was left unchanged. Table 12 gives a breakdown of SRP's projected groundwater and recovery of LTSC pumping for Scenario 2. Figure 20 shows the relationship between the historical pumping from the Department's RoGR database and the re-calculated projected SRP pumping.

Table 12. New Projected SRP Pumping Volumes

	Af/yr
Groundwater	141,509
Recovery	15,405
TOTAL	**156,914**

5.3 Artificial Recharge – Scenario 2

As stated earlier the recharge volumes were reduced to reflect more surface water being used directly. Total volumes of water available for recharge were determined for each of the applicants based on eighty percent of their treatment capacity of available surface water being used to meet their projected demands for the year 2025 and the amount of effluent available for recharge as reported in the Applicants' Designation applications. This total volume of recharge per Applicant was then distributed proportionately to the facilities based on where the Applicant's projected to recharge in their application (Scenario 1). Some adjustment had to be made to the original proportions to adjust for permit limitations at USFs and GSFs. The volumes and distributions were held constant for the entire projection period from 2008 to 2108. Table 13 shows the artificial recharge for each applicant by facility for the year 2025 broken out by sub-basin. There was slight variability in the artificial recharge for the period between 2008 and 2025, however, given the 100-year projection the values used for the year 2025 and held constant until 2108 have the greatest impact.

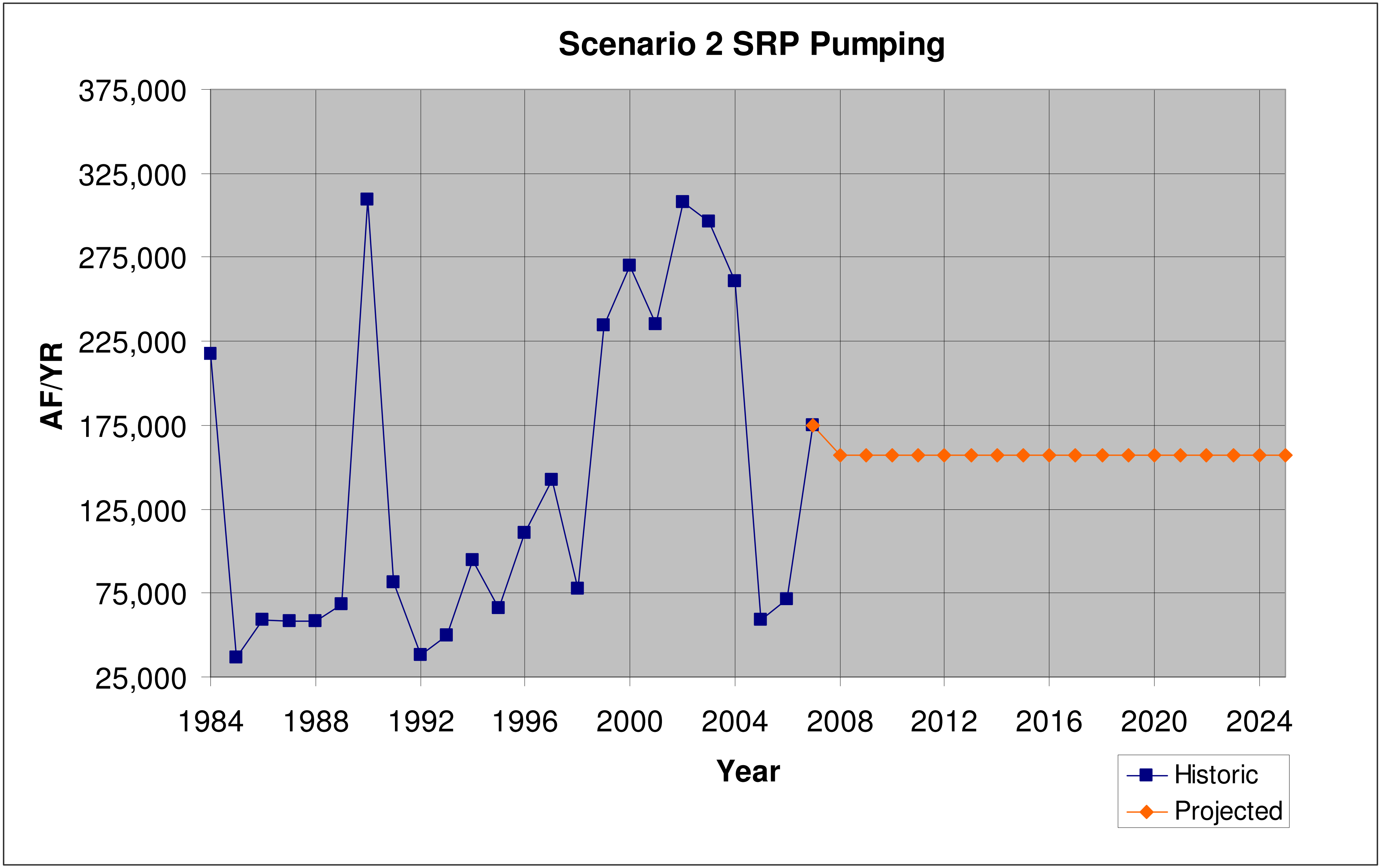


Figure 20. Scenario 2 - Re-Designation SRP Historic and Projected pumping.

Table 13. Scenario 2 - Projected USF Recharge per Provider

(acre-feet per year)

ESRV

Applicant	Recharge Facility	USF No.	2025
Apache Junction		**Total**	**0**
Chandler	GRUSP	71-516371	20,000
		Total	**20,000**
Gilbert	Agua Fria (Const.)	71-569776	0
	Neely Wildlife	71-520379	896
	GRUSP	71-516371	0
	Municipal ASR	71-591935	1,000
	Gilbert South	71-595198	5,138
	Tonopah Desert	71-593305	0
	Riparian Preserve	71-5564416	4,000
		Total	**11,034**
Mesa	GRUSP	71-516371	**11,525**
		Total	**11,525**
Scottsdale	West World	71-574911	1,000
	N. Scottsdale ASR	71-583022	1,400
	Water Campus	71-560648	13,700
		Total	**16,100**
Tempe	Kyrene	71-563943	3,400
	GRUSP	71-516371	0
		Total	**3,400**
		TOTAL	**62,059**

WSRV

Applicant	Recharge Facility	USF No.	2025
Avondale	Agua Fria (Const.)	71-569776	500
	Agua Fria (Mang.)	71-569775	1,000
	Avondale Wetlands	71-565257	15,00
	Hieroglyphic Mt.	71-584466	3,916
	NAUSP	71-588558	7,731
		Total	**28,147**
El Mirage	El Mirage Const.	71-211282	4,032
	Tonopah Desert	71-593305	508
		Total	**4,540**
Glendale	Arrowhead	71-591934	504
	Glendale ARF	71-586730	10,800*
	NAUSP	71-588558	14,930
		Total	**26,234**
Goodyear		**Total**	**0**
Peoria	Agua Fria (Const.)	71-569776	4,862
	Agua Fria (Mang.)	71-569775	4,862
	Beardsley	71-552497	4,000
	Hieroglyphic Mt.	71-584466	1,312
	NAUSP	71-588558	3,650
		Total	**18,686**
Phoenix	Cave Creek	71-595199	2,000
	GRUSP	71-516371	0
		Total	**2,000**
Surprise	Agua Fria (Const.)	71595199	**0**
	Surprise WWTP	71-516371	8,066
	Hieroglyphic Mt.	71-584466	0
	Tonopah Desert	71-593305	10,249
		Total	**18,315**
		TOTAL	**113,652**

* The projected recharge volume for this facility was erroneously doubled it should have been 5,400 af/yr.

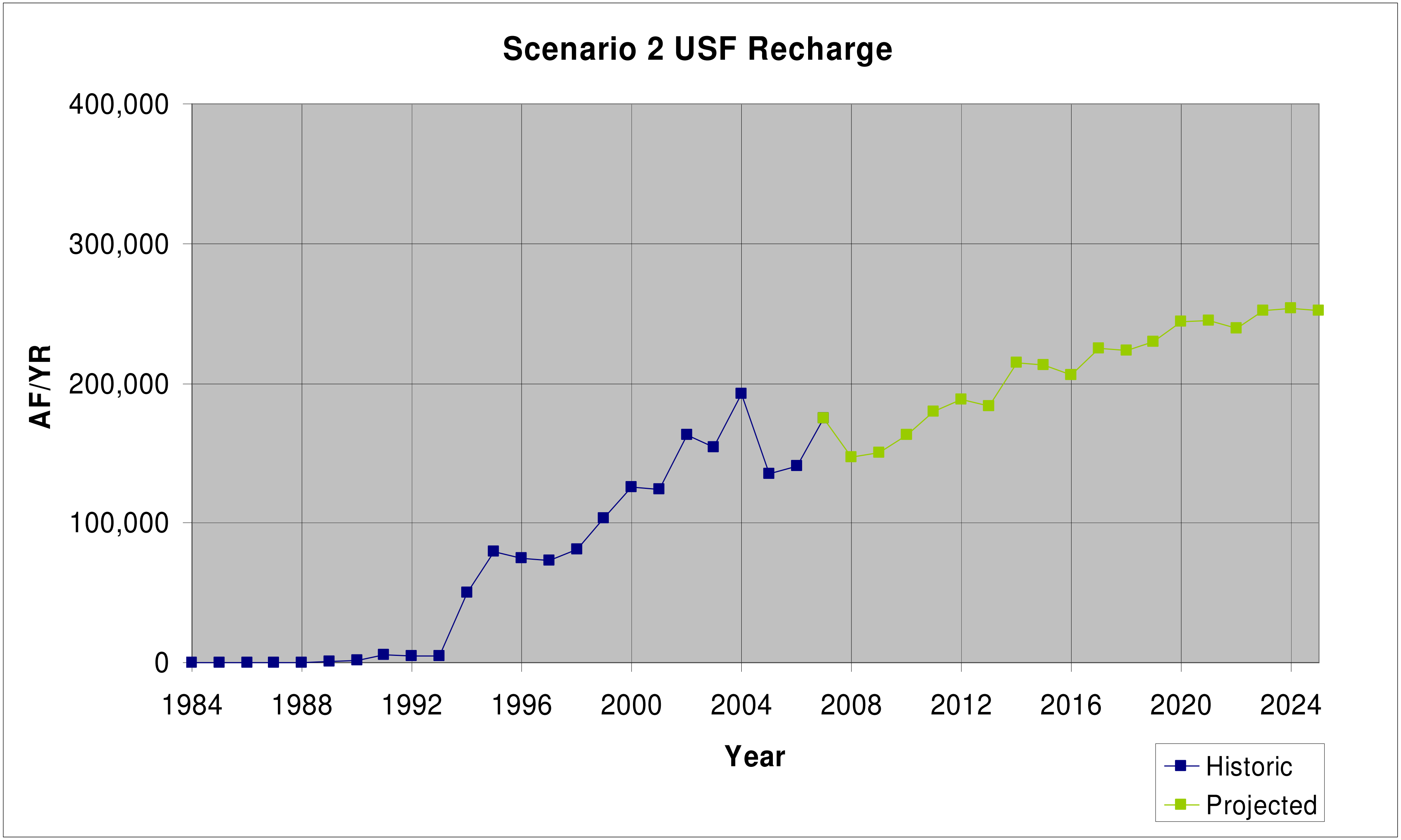


Figure 21. Scenario 2 - USF Recharge, Historic and Projected within the Study Area.

The USF recharge sites used for Scenario 1 (Figure 15) remained the same for this scenario. Figure 21 shows the relationship between historic USF recharge and projected USF recharge within the study area for Scenario 2. The historic volumes represent the total volumes of water recharged at the facilities. This includes the Applicants and all of the other entities that stored water at USFs. The projected volumes of USF recharge only represents recharge at USFs from the Applicants and the projected recharge at USFs to meet CAGRD obligations (Table 3). Compared to Scenario 1 the projected recharge in the study area was 30,843 af/yr less in Scenario 2 (based on the recharge volumes for the year 2025).

5.4 Modeling Adjustments to Pumping Scenario 2

As with Scenario 1 all the assumptions were incorporated into the scenario and the model was run through the year 2108. As with Scenario 1 there was a significant amount of pumping that was not simulated in the scenario by the year 2108. In an attempt to adjust for pumping in dry model cells all of the pumping was moved to the lowest most layer of the model (layer 3) for the projection period (2008 to 2108). This procedure increased the amount of simulated pumping, however, there was still a total of 7,171,240 acre-feet of pumping that was not simulated in the model between the years 2008 and 2108 due to model cells going dry

.5.5 Results – Scenario 2

The results from Scenario 2 showed less impact than Scenario 1. This is not surprising given that the projected pumping from the Applicants and SRP resulted in a reduction of 255,145 af/yr for the year 2025. There was also a reduction in artificial recharge, however, the difference when compare to Scenario 1 was only 30,843 af/yr for the year 2025. The overall results from Scenario 2 are shown in the DTW map for the year 2108 (Figure 22).

As would be expected the result show a similar pattern to Scenario 1 (Figure 18). The bright red areas indicating DTWs below 1,000 ft. bls were greatly reduced and the number of dry cells is significantly less than shown for Scenario 1.

However, the reduction in the number of dry cells is largely due to the AWS pumping not being re-distributed as it was in Scenario 1. This process was not deemed necessary since the results showed significant areas below the regulatory limit of 1,000 ft. bls. If that process was used the total amount of pumping not simulated would be reduced, but there would be more drawdown of the aquifer and more dry cells. As with Scenario 1 there was still a significant amount of AWS demand that did not meet the physical availability criteria for AWS pumping being above 1,000 feet bls.

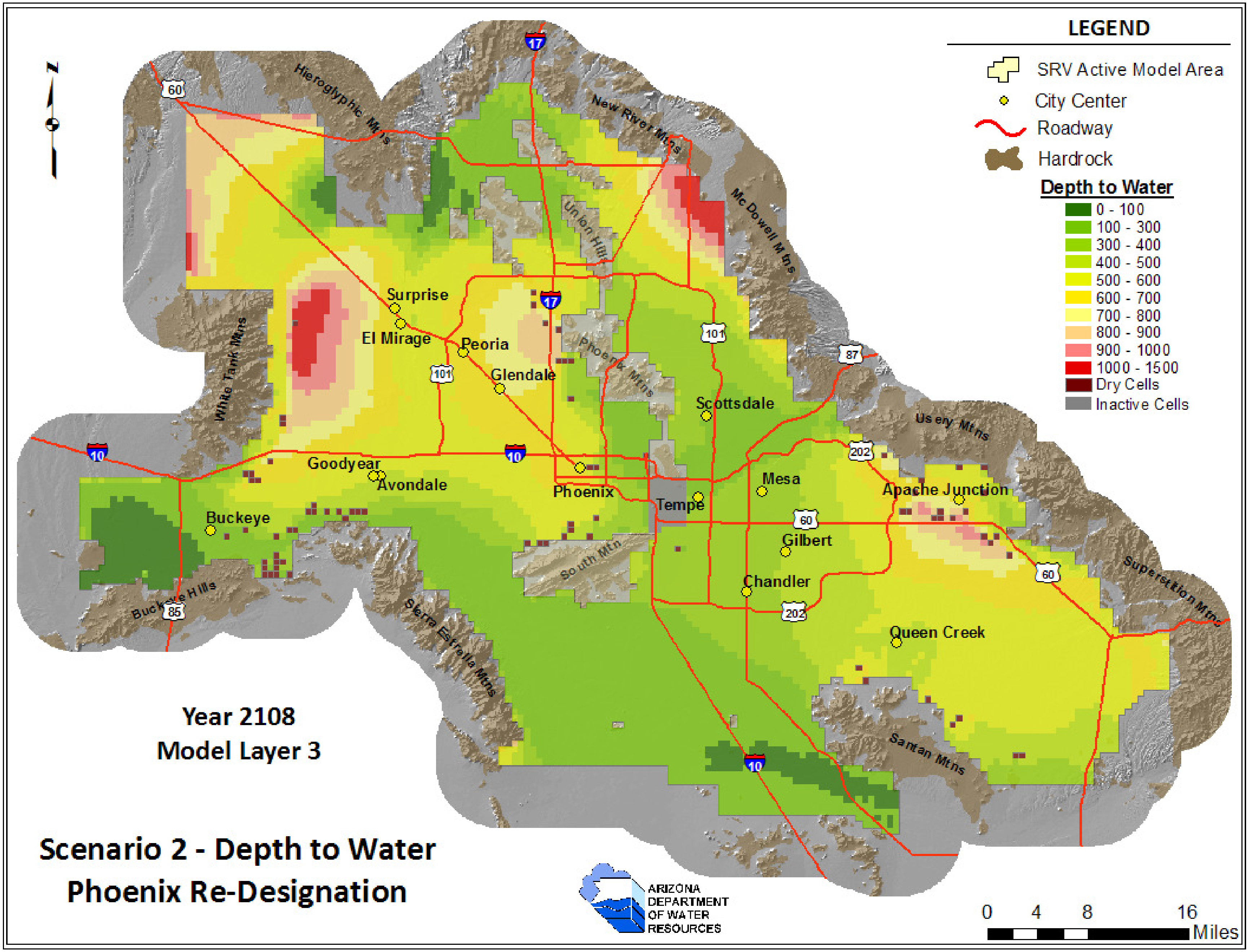


Figure 22. Scenario 2 - Depth to Water (DTW) of Layer 3 for the year 2108.

6.0 Scenario 3 – Direct Surface Water Use, 2020 Demands

The results from Scenario 2 still did not satisfy the AWS criteria for physical availability. A third scenario was developed based on the same assumptions as Scenario 2 except the Applicants' projected demands were based on their requested demands out to the year 2020, instead of the year 2025. The assumptions for the projected USF recharge by the Applicants and the projected SRP pumping were not changed from Scenario 2. All of the previously assumptions described in the Modeling Assumptions section were incorporated into the scenario.

6.1 Pumping – Applicants Scenario 3

A total volume of groundwater pumping and recovery was calculated, per applicant, to reflect direct use of surface water based on eighty percent of their treatment capacity for surface water. The volumes calculated were based on the Applicant's projected demands for the year 2020 instead of the year 2025. The volumes calculated were held constant from the 2008 to 2108. The groundwater pumping was distributed to the same wells the Applicants provided for Scenario 1. The volumes distributed were proportionately equivalent to the pumping distribution used for Scenario 1 for each of the projection years from 2008 to 2025.

The following table (Table 14) provides the groundwater and recovery volumes used for the Applicants for the year 2025. Only projected volumes for the year 2025 are shown since they are representative of the entire projection period. Figure 23 shows the Applicants historical municipal pumping and the projected pumping for Scenario 3 out to the year 2025. Compared to Scenario 2 the Applicant's projected groundwater pumping and recovery was reduced by 64,881 af/yr (based on the projections for the year 2025).

6.2 Modeling Adjustments to Pumping Scenario 3

As with the previous scenarios all the assumptions were incorporated into this scenario and the model was run out to the year 2108. In an attempt to adjust for pumping in dry model cells all of the pumping was moved to lowest most layer of the model (layer 3) for the projection period (2008 to 2108). And the same process was used to redistribute the pumping in model cells contained AWS pumping that went dry as was described for.

Table 14. Scenario 3 - Projected Groundwater Demand per Provider
(acre-feet per year)

ESRV

Water Provider	Pumping Type	2025
Apache Junction	Groundwater	10,145
	Recovery	383
	Total	**10,528**
Chandler	Groundwater	10,201
	Recovery	22,319
	Total	**32,520**
Gilbert	Groundwater	21,380
	Recovery	0
	Total	**21,380**
Mesa	Groundwater	16,127
	Recovery	978
	Total	**17,105**
Scottsdale	Groundwater	13,923
	Recovery	194
	Total	**14,121**
Tempe	Groundwater	6,975
	Recovery	71
	Total	**7,046**
	TOTAL	**102,700**

WSRV

Water Provider	Pumping Type	2025
Avondale	Groundwater	1,700
	Recovery	22,423
	Total	**24,123**
El Mirage	Groundwater	3,545
	Recovery	4,541
	Total	**8,086**
Glendale	Groundwater	7,525
	Recovery	394
	Total	**7,919**
Goodyear	Groundwater	18,474
	Recovery	0
	Total	**18,474**
Peoria	Groundwater	2,844
	Recovery	1,100
	Total	**3,944**
Phoenix	Groundwater	39,742
	Recovery	0
	Total	**39,742**
Surprise	Groundwater	16,723
	Recovery	0
	Total	**16,723**
	TOTAL	**119,011**

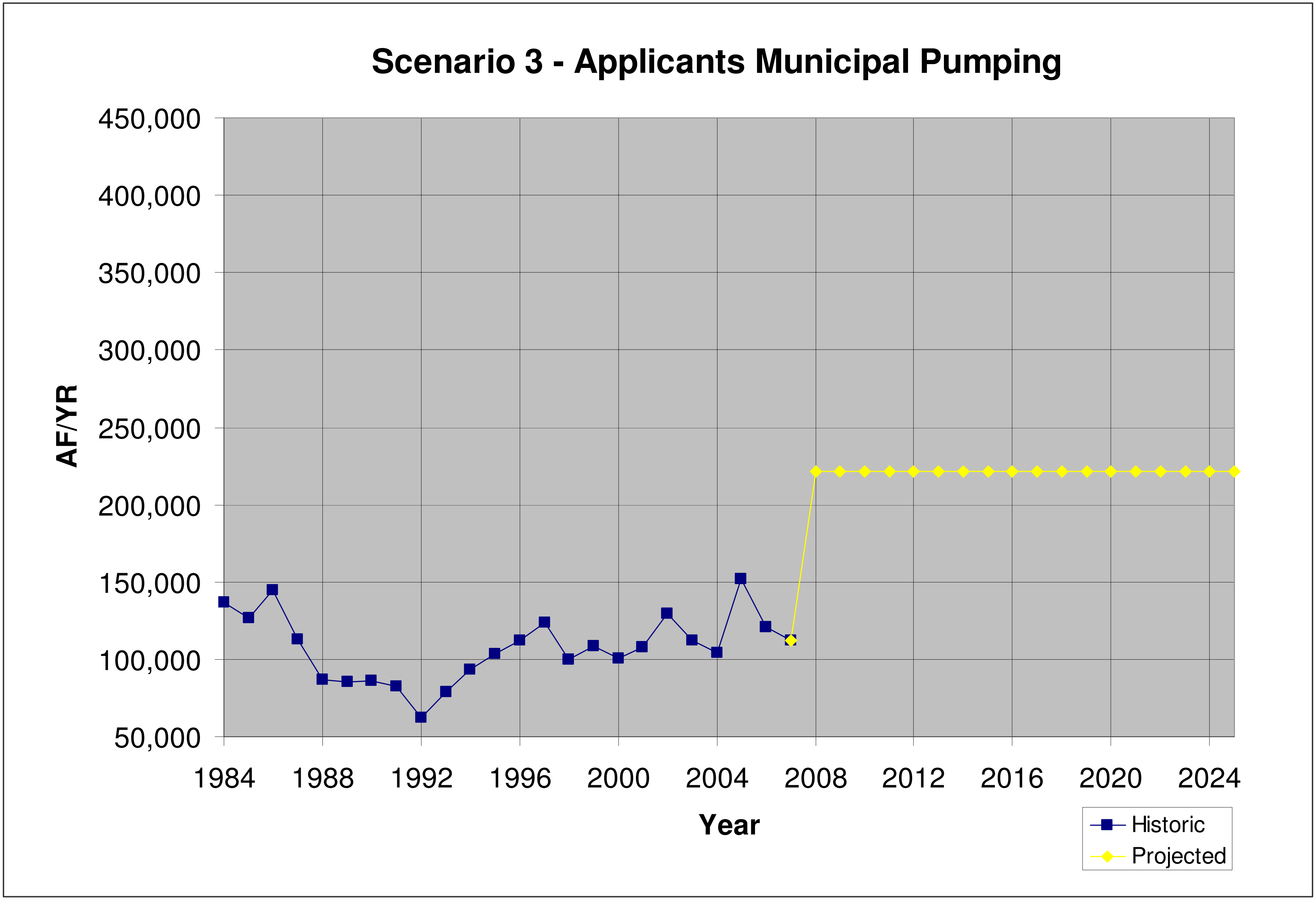


Figure 23. Scenario 3 - Applicants Historic and Projected Municipal pumping.

Scenario 1. These two procedures increased the amount of simulated pumping, however, there was still 3,864,953 acre-feet of total pumping that was not simulated in the model between the years 2008 and 2108 due to model cells going dry.

6.3 Results – Scenario 3

The results from Scenario 3 showed less impact than either of the previous two scenarios. Compared to Scenario 2 there was a projected reduction in the Applicants' pumping of 64,881 af/yr (for the year 2025) and no change in the amount of recharge. When compared to Scenario 1 there was a total reduction of 320,026 af/yr (for the year 2025) in the projected pumping. The reduction in pumping is a result of decreases in the Applicants pumping, possible changes in SRP pumping and changes in the amount of LTSC's that needed to be removed from the scenario. The overall results from Scenario 3 are shown in the DTW map for the year 2108 (Figure 24). Besides the reduction in the projected pumping the results are also affected by the reduction in pumping not simulated due to "dewatered" modeling cells.

The overall results follow a similar pattern to the previous scenarios. The areas below 1,000 ft. bls (bright red on the map) were greatly reduced. The area in the northeast corner of the map is still present, however, there is no AWS pumping located in that area. The area in the western portion of the study area, next to the White Tank Mountains was greatly improved to just a few cells below the regulatory limit. The other area of concern is the area around Apache Junction in the eastern portion of the study area. This area indicates numerous cells with AWS pumping that could not be simulated due to dry cells

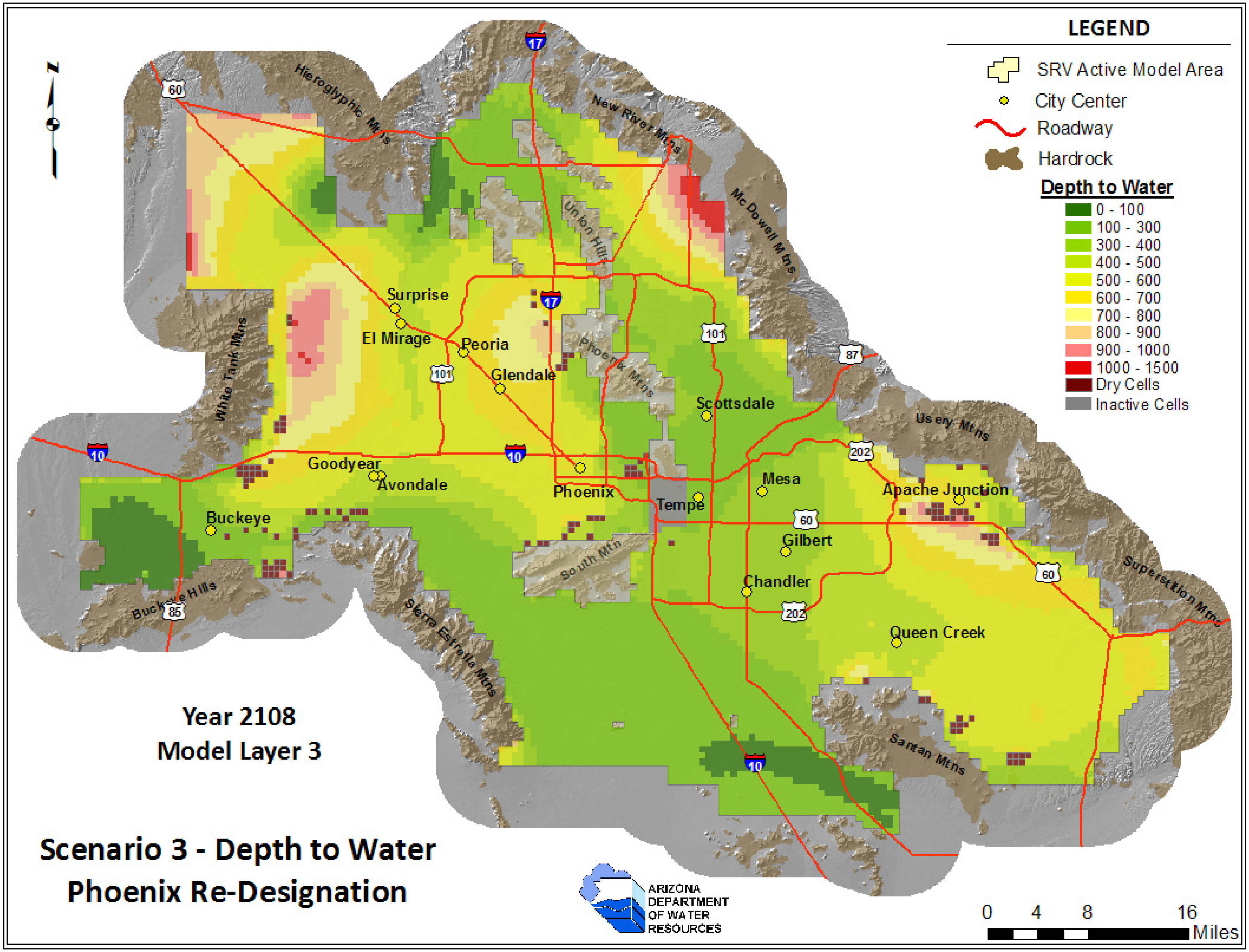


Figure 24. Scenario 3 - Depth to Water (DTW) of Layer 3 for the year 2108.

7.0 Base Scenario– Current Designation Scenario

To have a better understanding of the impact of the increased demand from the Applicants a baseline AWS scenario was created to simulate the current conditions projected out 100 years. The Applicants' pumping was based on their current Designations. The assumption for the Applicants' projected USF recharge was based on the volumes of water that they would be able to recharge. This Base Scenario used the same base assumptions as the previous scenarios. The projected SRP pumping used for as Scenario 2 and 3 remained the same for this scenario. All of the previously assumptions described in the Modeling Assumptions section were incorporated into the scenario.

7.1 Pumping – Applicants' Base Scenario

A total volume of groundwater pumping and recovery for the Applicants was determined based on their current designated volumes. The distribution of the pumping followed the same methodology that was used for Scenario 2 and 3. The current Designations do not distinguish between groundwater pumping and recovery of LTSC. The proportion of groundwater pumping and recovery calculated from the Applicants' current submittals was used to split the total volume of pumping up into these categories. The pumping was distributed proportionately to the wells that the Applicants provided for each of the projection years from 2008 to 2025.

The following table (Table 15) provides the groundwater and recovery volumes used for the applicants for the year 2025. Only projected volumes for the year 2025 are shown since they are representative of the entire projection period. Figure 25 shows the Applicants historical municipal pumping and the projected pumping for the Base Scenario out to the year 2025. Compared to Scenario 3 the Applicant's projected groundwater pumping and recovery was reduced by 29,891 af/yr (based on the projections for the year 2025).

7.3 Artificial Recharge – Base Scenario

The Applicants' projected USF recharge was based on the volumes of water that could be recharged given the available sources of water that they included in their applications. This total volume of recharge per Applicant was then initially distributed proportionately to the facilities based on where the Applicants projected to recharge in their application (Scenario 1). Due to the greatly increased volume of recharge more adjustment had to be made to the original proportions to adjust for permit limitations at USFs and GSFs. The potential volume of water for recharge by Apache Junction was calculated at 2,919 af/yr. However, this volume was not included in the scenario since Apache Junction did not project any artificial storage in their original submittal. The volumes and distributions were held constant for the entire projection period from 2008 to 2108. Table 16 shows the artificial recharge for each Applicant by facility for the year 2025 broken out by sub-basin that went into this scenario.

The USF recharge sites used for Scenario 1 (Figure 15) were used for this scenario with the addition of the SRP GSF. This GSF had to be added due to volume limitations at the facilities the City of Phoenix projected to store at in Scenario 1. The recharge in the SRP GSF was distributed in the area defined by the SRP pumping shown in Figure 12. Figure 26 shows the relationship between historic USF recharge and projected USF recharge within the study area for the Base Scenario. The historic volumes represent the total volumes of water recharged at the facilities. This includes the Applicants and all of the other entities that stored water at USF. The projected volumes represent just the recharge form the Applicants and CAGRD recharge at USFs.

Table 15. Base Scenario - Projected Groundwater Demand per Provider
(acre-feet per year)

ESRV

Water Provider	Pumping Type	2025
Apache Junction	Groundwater	2,526
	Recovery	279
	Total	**2,805**
Chandler	Groundwater	901
	Recovery	5,520
	Total	**6,421**
Gilbert	Groundwater	21,981
	Recovery	0
	Total	**21,380**
Mesa	Groundwater	2,824
	Recovery	14,833
	Total	**17,657**
Scottsdale	Groundwater	9,276
	Recovery	5,687
	Total	**14,963**
Tempe	Groundwater	2,842
	Recovery	3,620
	Total	**6,462**
	TOTAL	**70,289**

WSRV

Water Provider	Pumping Type	2025
Avondale	Groundwater	424
	Recovery	20,765
	Total	**21,189**
El Mirage	Groundwater	6,076
	Recovery	1,073
	Total	**7,149**
Glendale	Groundwater	4,603
	Recovery	13,085
	Total	**17,688**
Goodyear	Groundwater	15,458
	Recovery	478
	Total	**15,936**
Peoria	Groundwater	467
	Recovery	11,177
	Total	**11,644**
Phoenix	Groundwater	27,039
	Recovery	552
	Total	**27,591**
Surprise	Groundwater	20,334
	Recovery	0
	Total	**20,334**
	TOTAL	**121,531**

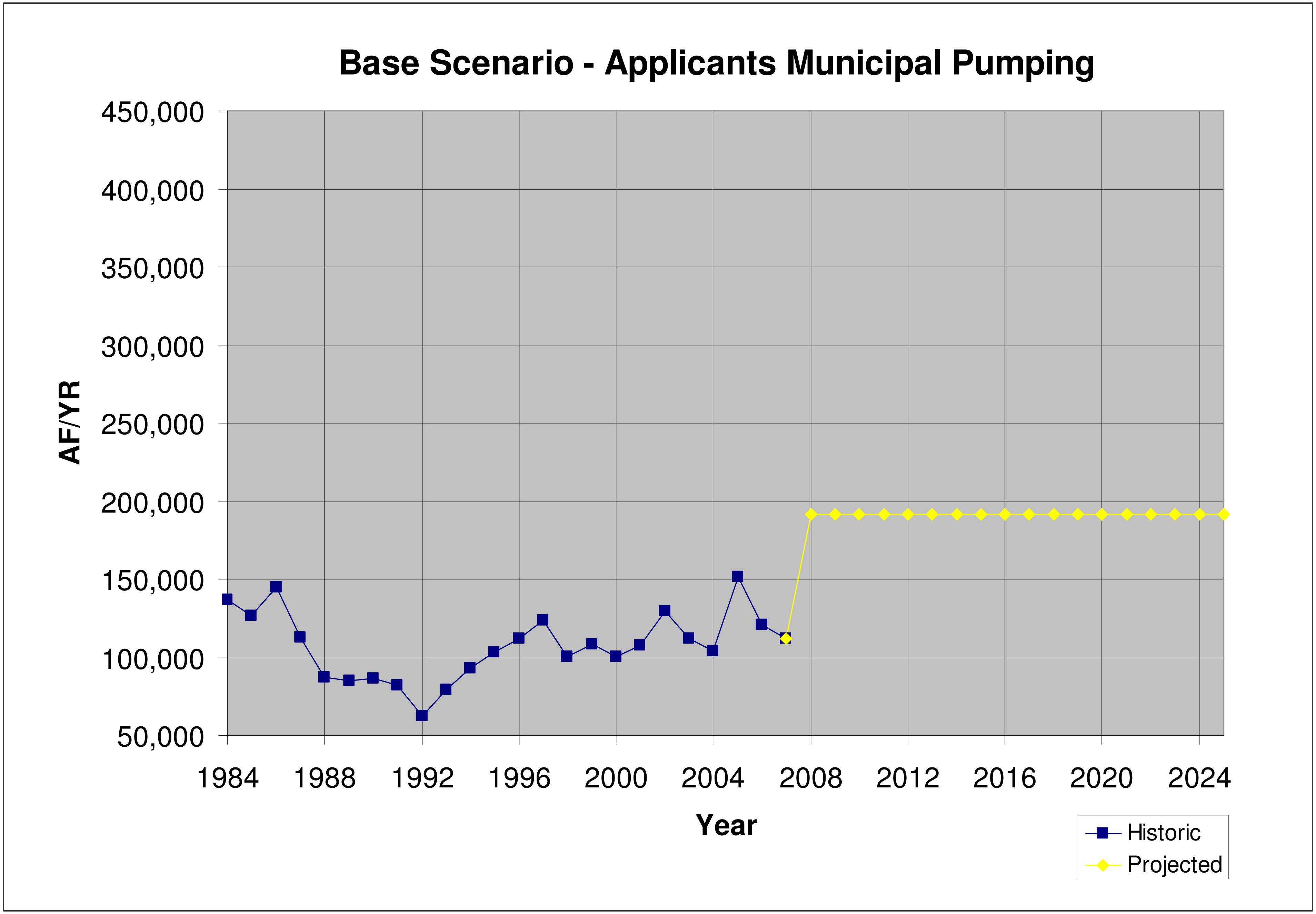


Figure 25. **Base Scenario - Applicants Historic & Projected Municipal pumping.**

7.4 Modeling Adjustments to Pumping Base Scenario

As with the previous scenarios all the assumptions were incorporated into this scenario and the model was run out to the year 2108. As with Scenario 3 the pumping was moved to the lowest most layer of the model (layer 3) for the projection period (2008 to 2108). And the pumping in model cells that went dry containing AWS pumping was redistributed. These procedures increased the amount of pumping simulated however, there was still a total of 2,717,839 acre-feet of total pumping that could not be simulated in the model between the years 2008 and 2108 due to model cells going dry.

7.5 Results – Base Scenario

The Base Scenario shows just a few very small areas below the 1,000 ft bls criteria around the edge of the model. Plus the number of dry model cells (and the amount of pumping not simulated) was greatly reduced from the previous scenarios. Again this is not surprising considering that compared to Scenario 1 this scenario simulated 348,734 af/yr less pumping for the period between 2025 and 2108. There was an even greater increase in the amount of recharge when compared with Scenario 1. The Base Scenario had 171,569 af/yr more recharge for the period between 2025 and 2108. The overall results for the Base Scenario are shown in the DTW map for the year 2108 (Figure 27).

Table 16. Base Scenario - Projected USF Recharge per Provider

(acre-feet per year)

ESRV

Applicant	Recharge Facility	USF No.	2025
Apache Junction		**Total**	**0**
Chandler	GRUSP	71-516371	41,455
		Total	**41,455**
Gilbert	Agua Fria (Const.)	71-569776	440
	Neely Wildlife	71-520379	79
	GRUSP	71-516371	78
	Municipal ASR	71-591935	88
	Gilbert South	71-595198	385
	Tonopah Desert	71-593305	1,758
	Riparian Preserve	71-5564416	352
		Total	**3,179**
Mesa	GRUSP	71-516371	65,496
		Total	**65,496**
Scottsdale	West World	71-574911	708
	N. Scottsdale ASR	71-583022	1,769
	Water Campus	71-560648	15,213
		Total	**17,689**
Tempe	Kyrene	71-563943	3,392
	GRUSP	71-516371	6,300
		Total	**9,692**
		TOTAL	**137,511**

WSRV

Applicant	Recharge Facility	USF No.	2025
Avondale	Agua Fria (Const.)	71-569776	378
	Agua Fria (Mang.)	71-569775	861
	Avondale Wetlands	71-565257	10,747
	Hieroglyphic Mt.	71-584466	3,906
	NAUSP	71-588558	2,922
		Total	**18,814**
El Mirage		**Total**	**0**
Glendale	Arrowhead	71-591934	1,169
	Glendale ARF	71-586730	7,013
	NAUSP	71-588558	38,573
		Total	**46,755**
Goodyear	Agua Fria (Const.)	71-569776	9,486
	Goodyear SAT	71-566367	229
	Hieroglyphic Mt.	71-584466	8,027
		Total	**17,742**
Peoria	Agua Fria (Const.)	71-569776	3,193
	Agua Fria (Mang.)	71-569775	3,193
	Beardsley	71-552497	4,560
	Hieroglyphic Mt.	71-584466	3,315
	NAUSP	71-588558	8,479
		Total	**22,760**
Phoenix	SRP ID	72-553133	64,138
	Cave Creek Facility	71-595199	8,771
	GRUSP	71-516371	64,138
		Total	**137,047**
Surprise	Agua Fria (Const.)	71595199	1,912
	Surprise WWTP	71-516371	4,514
	Hieroglyphic Mt.	71-584466	1,912
	Tonopah Desert	71-593305	1,912
		Total	**10,249**
		TOTAL	**253,367**

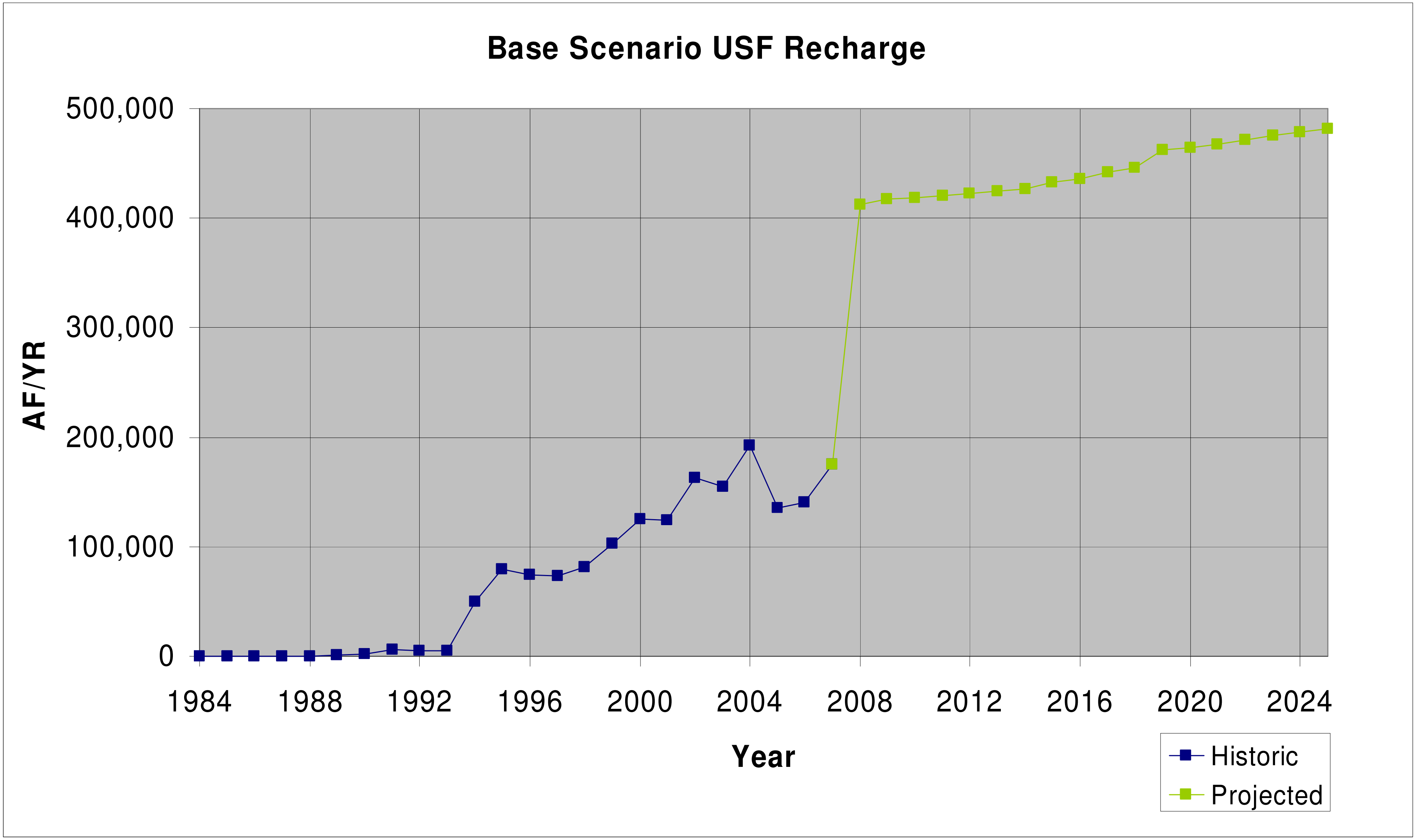


Figure 26. Base Scenario - USF Recharge, Historic and Projected within the Study Area.

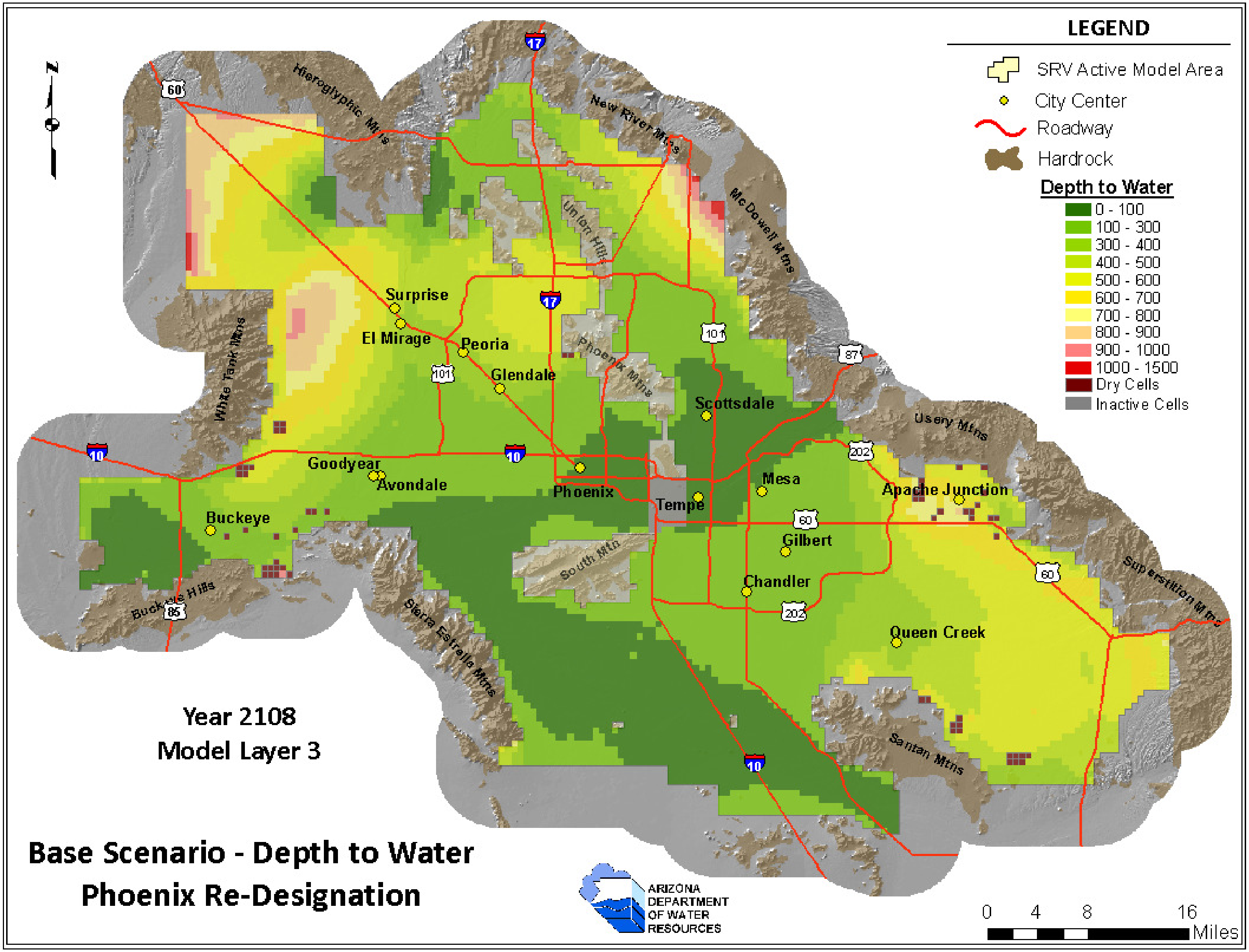


Figure 27. Base Scenario - Depth to Water (DTW) of Layer 3 for the year 2108.

8.0 Scenario 4 – Final Designation Scenario

The final scenario reflects the additional recovery of LTSC within the "safe harbor" of USFs, along with a few adjustments to the projected recharge by the Applicants. The projected recharge was altered to reflect the Applicants recharging at facilities with associated recovery wells. Another change from the previous scenarios was to move the projected CAGRD from two facilities in the Hassayampa subbasin to the Superstition Mountain USF in the East Salt River Valley, based on discussions with CAGRD.

8.1 Pumping – Scenario 4

In this scenario the pumping for the Applicants is broken down into three categories; groundwater, recovery outside the area of impact (AoI), and recovery inside the AoI. For this study recovery wells within the AoI were determined to be recovery wells located within one mile of a recharge facility that the well was permitted to recover from. The volumes for all of the Applicants' pumping were held constant between the years 2008 to 2108. The basis for the location and distribution of the Applicants' groundwater pumping was determined using the same process as described for Scenarios 2 and 3, with the exception that any pumping outside of the study area was moved to wells within the study area.

The distribution and amount of recovery that was submitted for Scenario 1 was used as a base for the recovery outside of the AoI. Recovery wells were added when none were submitted by the Applicant or greater pump capacity was needed to handle the volume of recovery. The volume of LTSCs recovered for a specific facility was altered from Scenario 1 to reflect limitations in the amount of LTSCs stored at a facility and storage limitations of a specific facility. If an Applicant had recovery wells inside of the AoI, the wells and associated recovery volumes were added to this scenario.

Table 17 provides the pumping volumes used for the Applicants for the year 2025. Only projected volumes for the year 2025 are shown since they are representative of the entire projection period. The Applicants are roughly split into the ESRV and WSRV depending on which subbasin the bulk of their service area is located in. Figure 28 shows the historical municipal pumping from these providers and the projected

Table 17. Scenario 4 - Projected Groundwater Demand per Provider
(acre-feet per year)

ESRV

Water Provider	Pumping Type	2025
Apache Junction	Groundwater	2,769
	Total	**2,769**
Chandler	Groundwater	10,248
	Recovery Outside AoI	22,500
	Recovery Inside AoI	11,854
	Total	**44,603**
Gilbert	Groundwater	6,194
	Recovery Outside AoI	15,306
	Recovery Inside AoI	2.227
	Total	**23,728**
Mesa	Groundwater	12,313
	Recovery Outside AoI	5,039
	Total	**17,352**
Scottsdale	Groundwater	13,075
	Recovery Outside AoI	1,105
	Recovery Inside AoI	3,387
	Total	**17,567**
Tempe	Groundwater	6,294
	Recovery Outside AoI	962
	Recovery Inside AoI	3,400
	Total	**10,656**
	TOTAL	**116,675**

WSRV

Water Provider	Pumping Type	2025
Avondale	Groundwater	1,663
	Recovery Outside AoI	14,224
	Recovery Inside AoI	15,000
	Total	**30,888**
El Mirage	Groundwater	3,545
	Recovery Outside AoI	4,540
	Total	**8,085**
Glendale	Groundwater	7,355
	Recovery Outside AoI	672
	Recovery Inside AoI	16,001
	Total	**24,028**
Goodyear	Groundwater	5,025
	Recovery Outside AoI	8,240
	Total	**13,265**
Peoria	Groundwater	2,773
	Recovery Outside AoI	1,221
	Recovery Inside AoI	6,053
	Total	**10,048**
Phoenix	Groundwater	38,114
	Recovery Outside AoI	3,827
	Total	**41,941**
Surprise	Groundwater	1,032
	Recovery Outside AoI	15,685
	Total	**16,717**
	TOTAL	**144,972**

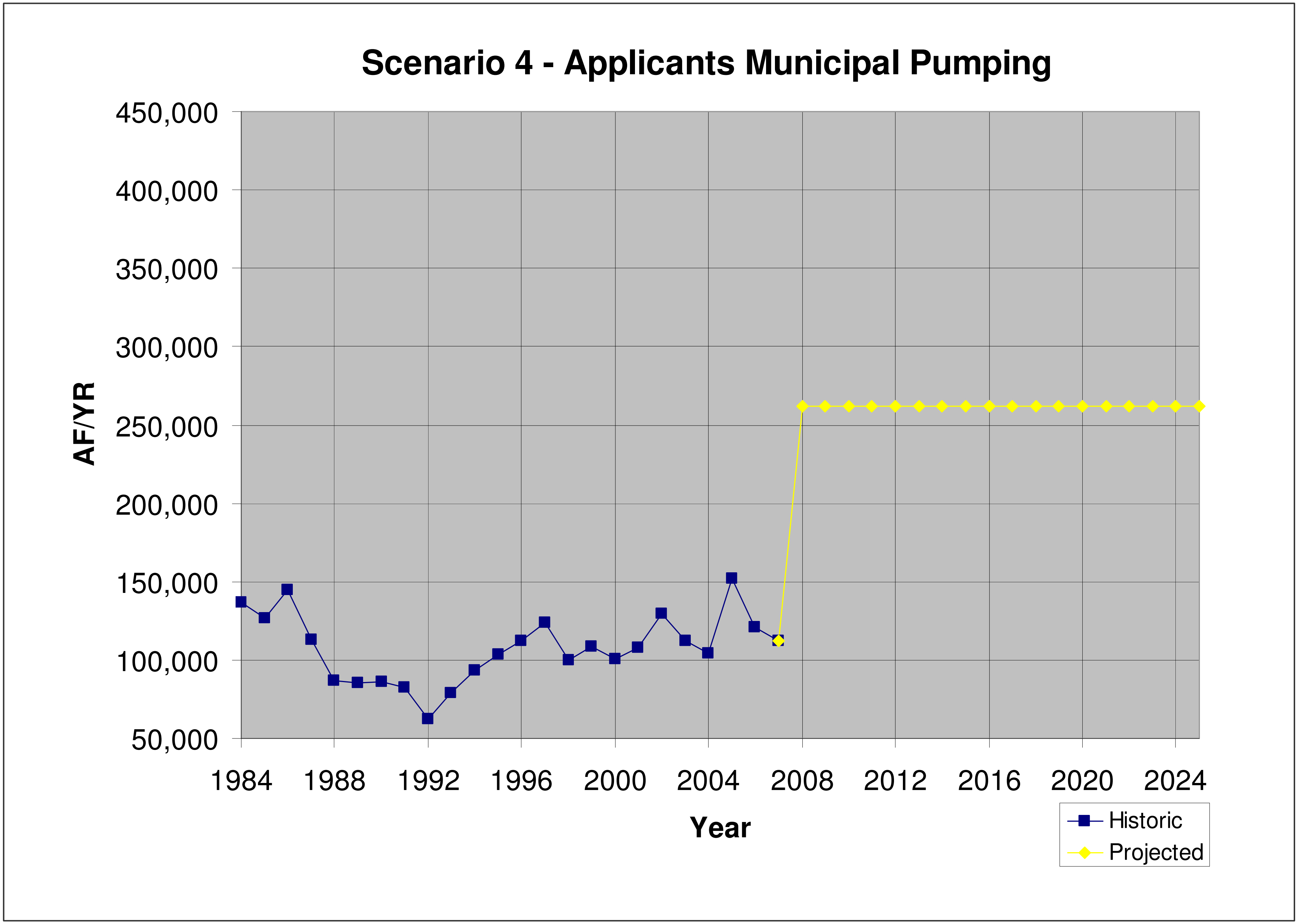


Figure 28. Scenario 4 - Applicants Historic and Projected Municipal pumping.

municipal pumping for Scenario 4.

The issued AWS demands were also modified for this Scenario. The first change was in the projected pumping for Arizona American – Agua Fria. The projected groundwater volume of their committed demand was reduced by 9,093 af/yr to reflect a new surface water treatment facility. The second change was to ensure the most up-to-date issued AWS demands were used in the scenario (based on applications that had been submitted prior to the Applicants' submittals). A total of six new permits were added to the original issued AWS demands (as of the end of April, 2010) in the Phoenix AMA. The total groundwater from the six new permits was 1,753 af/yr. Only four of the permits were located in the study area, resulting in an increase of 1,716 af/yr in issued AWS demands. A complete list of issued AWS demands and the volumes used in this scenario can be found in Appendix A.

8.3 Artificial Recharge – Scenario 4

The Applicants' projected USF recharge was based on information submitted with their re-Designation applications. Total volumes of water available for recharge were determined for each of the Applicants based on available surface water being used to meet their projected demands for the year 2025 and the amount of effluent available for recharge as reported in the Applicant's re-Designation applications. The Applicants' recharge volumes were first distributed to the facilities with associated recovery wells located in the AoI of that facility. The remaining volume of available recharge was distributed to other USFs or GSFs depending on various factors such as projected recovery of LTSC from a specific facility, facility location, and facility storage limitations. The volumes and distributions were held constant for the entire projection period from 2008 to 2108.

The locations of the USF recharge facilities used for this scenario are shown in Figure 29. Table 18 shows the artificial recharge for each Applicant by facility for the year 2025 broken out by sub-basin. Figure 30 shows the relationship between historic USF recharge and projected USF recharge within the study area for Scenario 4. The historic volumes represent the total volumes of water recharged at the facilities. This includes the Applicants' and all of the other entities that stored water at USFs.

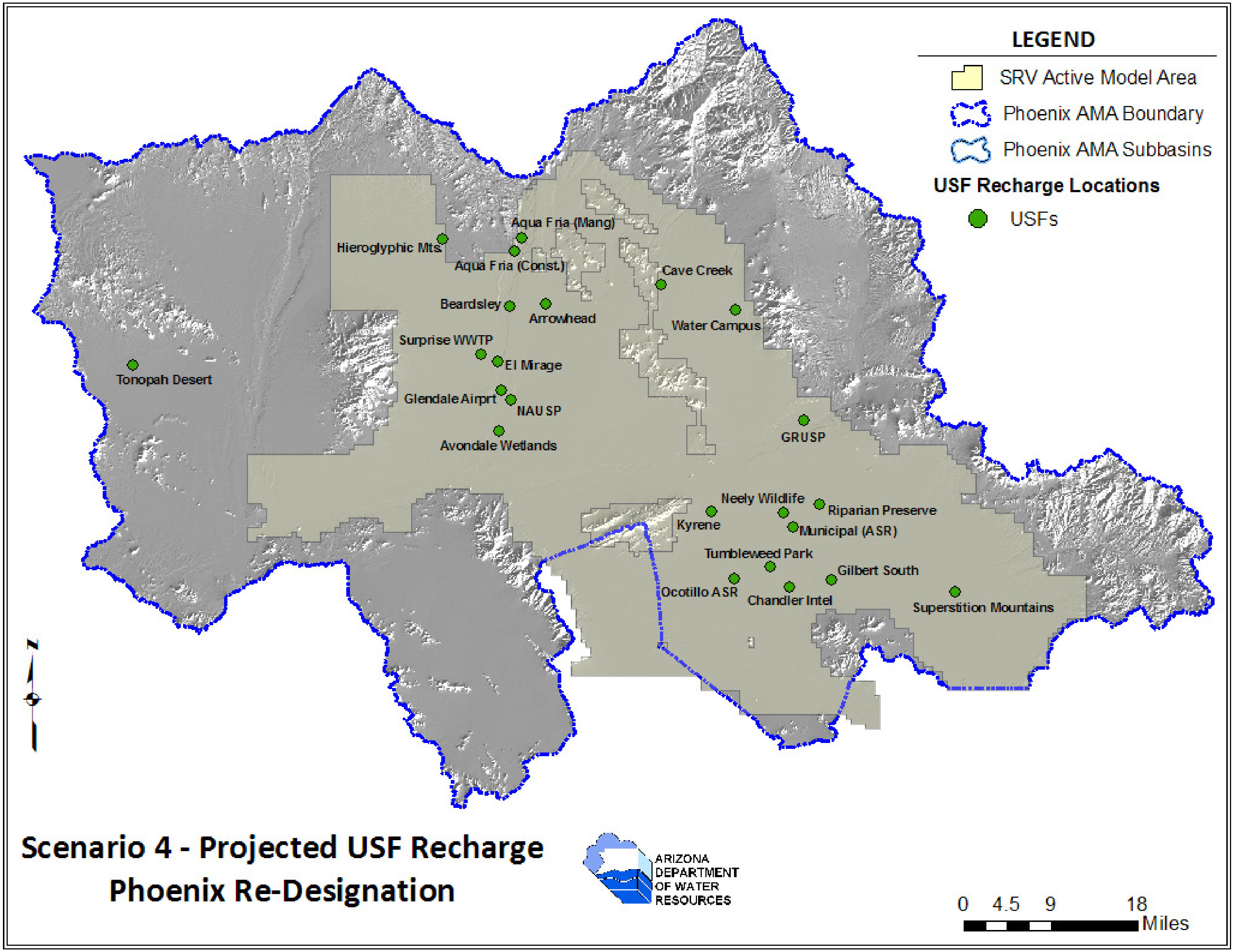


Figure 29. Scenario 4 - Locations of USF Recharge.

Table 18. Scenario 4 - Projected USF/GSF Recharge per Provider.
(acre-feet per year)

ESRV

Applicant	Recharge Facility	USF No.	2025
Apache Junction		**Total**	**0**
Chandler	GRUSP	71-516371	7,871
	Intel	71-541455	1,423
	New Magma ID	72-534888	11,548
	Ocotillo ASR	71-583023	1,292
	Tumbleweed Park	71-560347	9,139
		Total	**31,273**
Gilbert	Neely Wildlife	71-520379	2,227
	Municipal ASR	71-591935	2,172
	Gilbert South	71-595198	7,537
	Riparian Preserve	71-564416	4,344
		Total	**16,280**
Mesa	GRUSP	71-516371	11,526
		Total	**11,526**
Scottsdale	Water Campus	71-560648	10,289
	Total		**10,289**
Tempe	Kyrene	71-563943	3,400
		Total	**3,400**
		TOTAL	**72,768**

WSRV

Applicant	Recharge Facility	USF No.	2025
Avondale	Agua Fria (Const.)	71-569776	1,141
	Agua Fria (Mang.)	71-569775	1,000
	Avondale Wetlands	71-565257	15,000
	Hieroglyphic Mt.	71-584466	3,916
	NAUSP	71-588558	7,731
		Total	**28,788**
El Mirage	El Mirage Const.	71-211282	4,032
	Agua Fria (Const.)	71-569776	508
		Total	**4,540**
Glendale	Arrowhead	71-591934	2,300
	Glendale ARF	71-586730	4,084
	NAUSP	71-588558	10,234
		Total	**16,618**
Goodyear	Agua Fria (Const.)	71-569776	5,914
	Agua Fria (Mang.)	71-569775	5,914
	Hieroglyphic Mt.	71-584466	5,914
		Total	**17,742**
Peoria	Agua Fria (Const.)	71-569776	5,178
	Agua Fria (Mang.)	71-569775	5,178
	Beardsley	71-552497	5,389
	Hieroglyphic Mt.	71-584466	5,178
	NAUSP	71-588558	12,134
		Total	**33,057**
Phoenix	Cave Creek	71-595199	2,000
		Total	**2,000**
Surprise	Surprise WWTP	71-516371	8,066
	Tonopah Desert	71-593305	10,249
		Total	**18,315**
		TOTAL	**121,060**

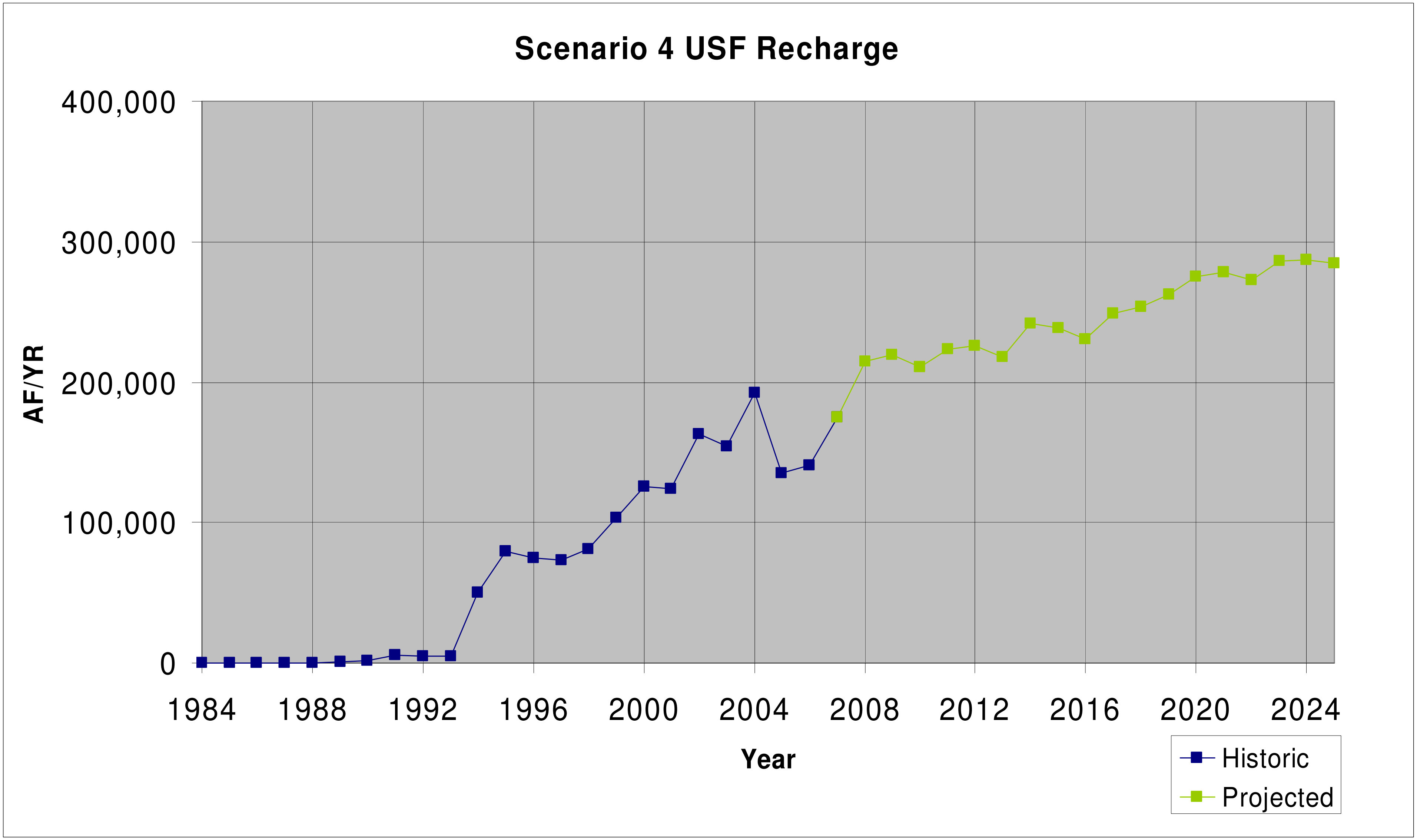


Figure 30. Scenario 4 - USF Recharge, Historic and Projected within the Study Area.

The projected volumes represent just the projected recharge from the Applicants and CAGRD recharge at USFs.

8.4 Modeling Adjustments to Pumping Scenario 4

As with the previous scenarios all the assumptions were incorporated into this scenario and the model was run out to the year 2108. As with Scenario 3 and the Base Scenario pumping was moved to the lowest most layer of the model (layer 3) for the projection period (2008 to 2108).

A more detailed approach for redistributing AWS related pumping that was not included due to the model cells going dry or located in a model cell with a depth to water below 1,000 ft bls was used for this scenario. First an attempt was made to move the effected pumping to a related well location (i.e. pumping for a City of Phoenix well located in a dry model cell was moved to a different City of Phoenix well). If this method did not work then the AWS related pumping was moved to a hypothetical well location within the associated service area. By utilizing these methods all of the AWS related demands were included in the 100-year projection.

These procedures increased the amount of pumping simulated however, there was still a total of 4,052,288 acre-feet of pumping that was not simulated in the model between the years 2008 and 2108 due to model cells going dry. None of this pumping is associated with issued or current AWS determinations, consistent with the physical availability critera.

8.5 Results – Scenario 4

Compared to Scenario 3 the pumping in the model for this scenario was increased by 36,149 af/yr. Recharge was increase for the projection period by 38,663 af/yr. Over the model area Scenario 4 had a net increase in demand of approximately 2,500 af/yr compared to Scenario 3. The overall results for Scenario 4 are shown in the DTW map for the year 2108 (Figure 31).

Scenario 4 shows less of a contrast between the low areas (in red) and the higher areas (in green) when compared to the other scenarios. The areas below 1,000 ft. DTW are limited to the area in the northeast corner of the study area and a few cells on the

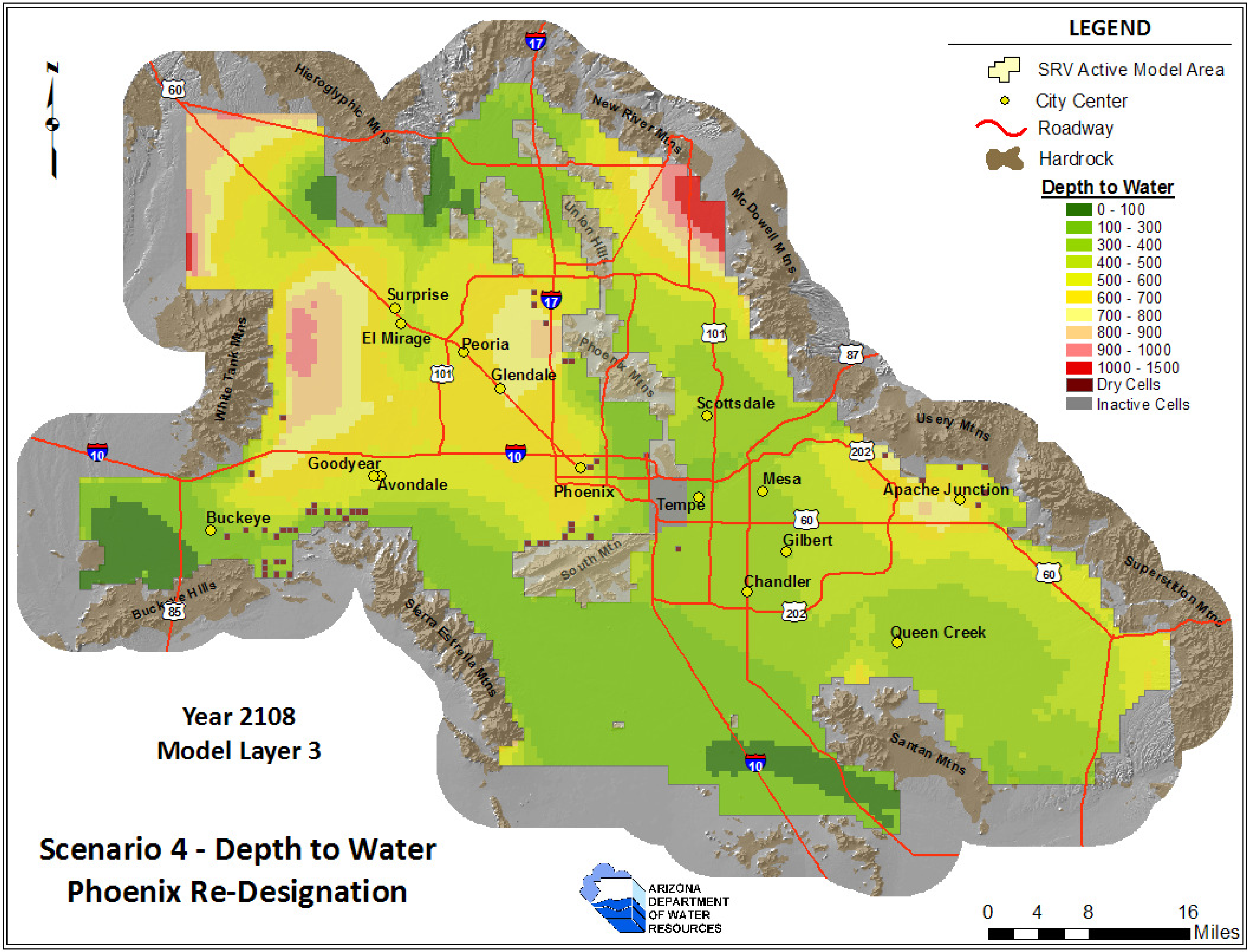


Figure 31. Scenario 4 - Depth to Water (DTW) of Layer 3 for the year 2108.

northwestern edge of the model. Model cells going dry follow a similar pattern to the previous scenarios. However, the number of dry model cells (and the amount of pumping not simulated) was reduced from the previous scenarios. This was largely due to a more selective process in redistributing the AWS pumping located in dry cells and the reduction of projected pumping in some of the critical areas such as Apache Junction and east of the White Tank Mountains.

One of the key differences compared with the other scenarios is that all AWS related pumping is included for the full 100-year simulation in this scenario. This scenario is an improvement over the previous scenarios concerning the impact to the aquifer. Scenario 4 demonstrates the impact that strategically locating pumping and recharge can have on the regional aquifer.

9.0 Summary and Conclusions

As was stated at the start of this report the purpose of running the predictive scenarios was to determine the physical availability for the re-designation applications. Scenario 4 represents the final model run used to demonstrate physical availability for the AWS re-Designation applications. This section provides a brief summary on how the predictive scenarios compare with each other and the effect these changes had on the results. The focus will be on the changes in pumping and recharge. All values reported within this section deal exclusively with the values within the study/ active model area.

The total predictive pumping used in the scenarios covers a large range, from a high of 1,457,706 af/yr (Scenario 1, year 2025) to a low of 1,175,734 af/yr (Scenario 3, year 2025) a difference of 281,972 af/yr. Scenario 1 shows a distinctive pattern when compared to the other Scenarios (Figure 32). This is a result of the Applicant's pumping being increased over the projection period up to the year 2025. Since the Applicant's pumping was held constant in Scenarios 2, 3, and 4 the changes in the total pumping volume are a result of agricultural pumping being urbanized over this time period.

The total predictive recharge shows less variability than the predictive pumping (Figure 33). The recharge volumes used in the scenarios start off in the year 2008 ranging between 824,151 af/yr (Scenario 1) to a maximum of 953,596 af/yr in Scenario 4, a difference of 129,445 af/yr. However by the year 2025 the total recharge varies by no more than 38,875 af/yr between the scenarios.

There are significant differences in the results from Scenario 2 (Figure 22) and Scenario 4 (Figure 31). The difference between the pumping and recharge for the two scenarios, however, is not that great. Scenario 4 has approximately 10,000 af/year less pumping and about 38,000 af/yr more recharge than Scenario 2. This results in a net difference of 48,000 af/yr between the two scenarios. For an area the size of the model area this is not a large imbalance. However, the difference in the results is fairly dramatic and the results point to the importance of balancing recharge and pumping on a more local level.

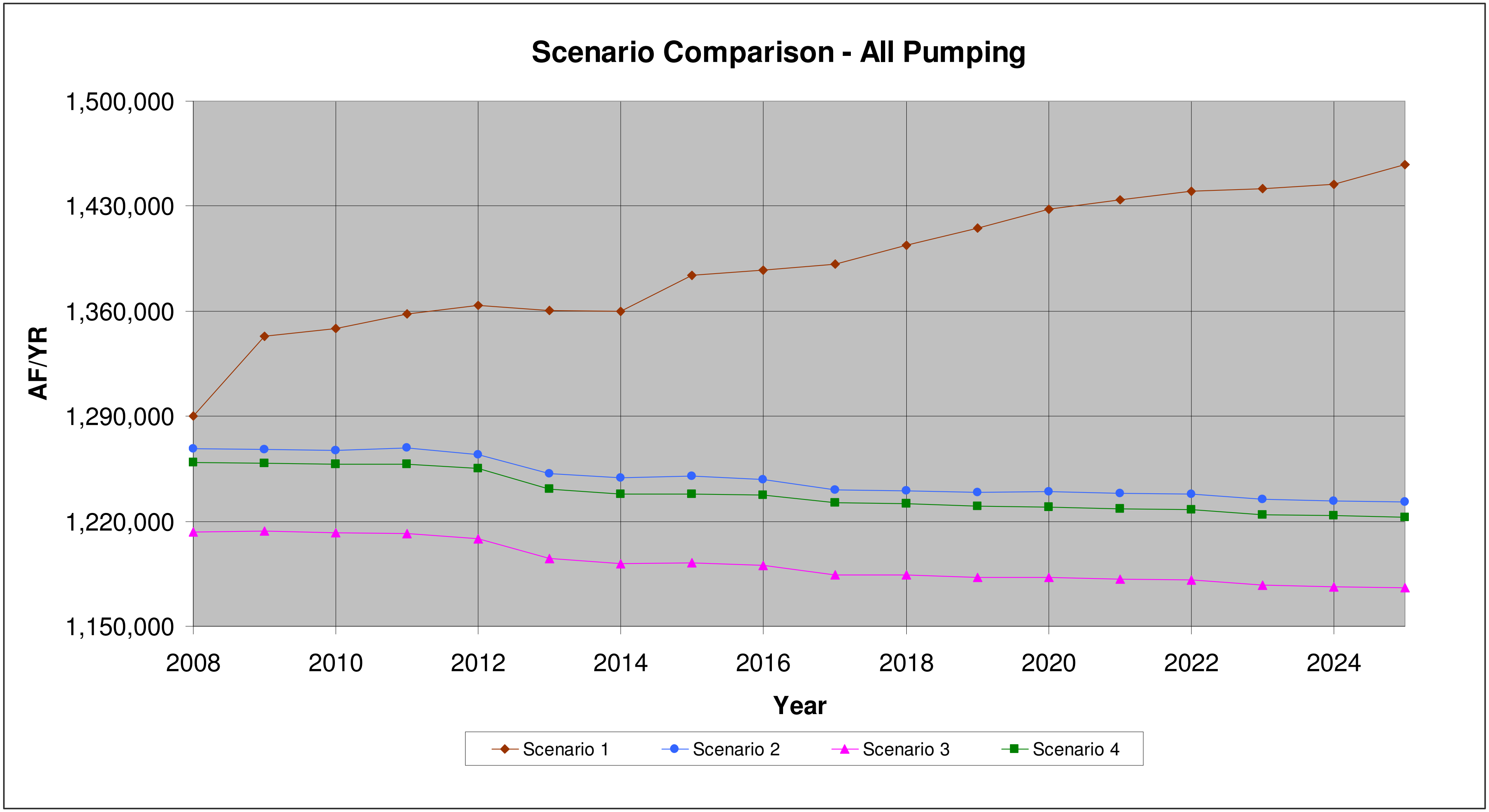


Figure 32. Comparison of All Predictive Pumping within the Model Area.

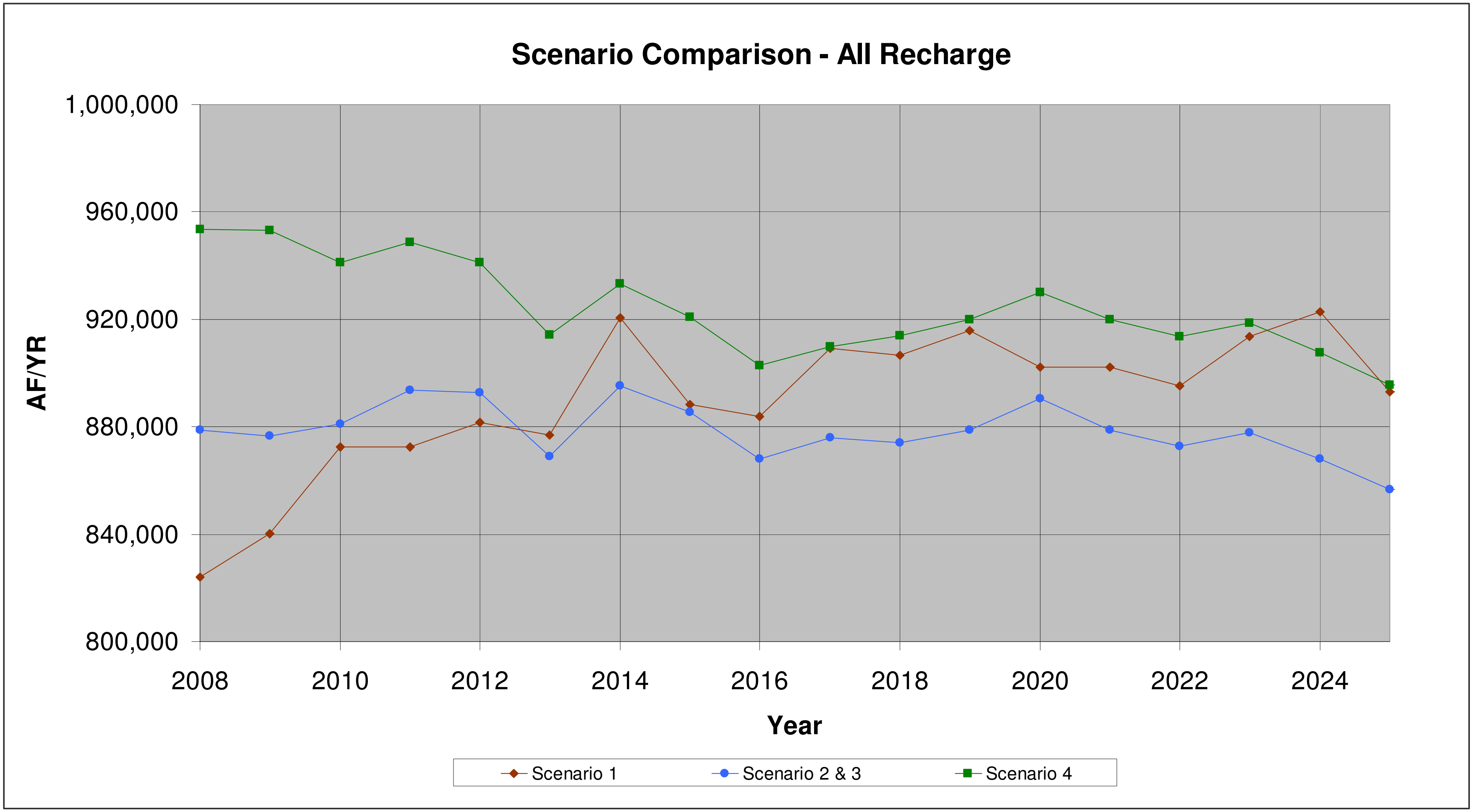


Figure 33. Comparison of All Predictive Recharge within the Model Area.

10.0 References

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Appendix A

Issued AWS Demand* for the Study Area as of May 30, 2010

(*These demands do not include any water providers that are part of this Re-designation study.)

Water Provider	Right Number	GW Demand (af/yr)
Adaman Mutual Water Company	56-002150.0000	432
Alma Ranchettes Co-Op	56-002153.0000	35
Arcadia Vista Improvement Co.	56-002154.0000	168
Arctic Ice & Water	56-002156.0000	16
Arizona American Water Co. - Paradise Valley (Water Co.)	56-002027.0000	7,137
Arizona Water Co - White Tanks	56-002001.0000	5,591
Arizona Water Co/Superior Sys	56-002002.0000	502
Arizona Water Company - Apache Junction	56-002000.0000	6,420
Arizona-American Water Company (Agua Fria)	56-002012.0000	67,025
Arizona-American Water Company (Sun City West)	56-002039.0000	6,305
Arizona-American Water Company (Sun City)	56-002038.0000	15,549
AZ Dept of Juvenile Corrections	56-002225.0000	120
Beardsley Water Company	56-002159.0000	5,290
Berneil Water Company	56-002004.0000	1,345
Brophy College Preparatory	56-002160.0000	54
Buckeye 243 LLC	28-700471	221
Chandler Heights Citrus	56-002504.0000	895
Chaparral Water Company	56-002283.0000	172
Circle City Water Co.	56-002166.0000	71
Citrus Acres	27-700529	115
Citrus Gardens Irrigation District	56-002345.0000	166
City Of Tolleson	56-002044.0000	850
Clearwater Utilities Co. Inc.	56-002165.0000	555
Copper Mountain Ranch (B-5-3) 4,5 & 8	28-401553	1,360
Country Home Mobile Village Pk	56-002314.0000	52
DaimlerChrysler Arizona	28-401647	6,256
Desert Hills Water Company	56-002169.0000	469
Diversified Water Utilities, Inc.	56-002258.0000	1,903
Friendly Village Mobile Hm Pk Of Orangewood	56-002174.0000	95
Gila Buttes Water Users Assoc.	56-002297.0000	231
Grand Vista (B-5-3) 12	56-000000	942
Grandview Water Co.	56-002175.0000	20
Greenfield Ranchettes	56-002241.0000	151
H2O Water Company, Inc.	56-002020.0000	7,544
Hacienda del Sol	56-002248.0000	45
Ironwood Crossing Unit 3	27-700330	337
Johnson Utilities Company	56-002346.0000	18,154
Liberty Park Improvement District	28-700375	1,738
Litchfield Park Service Co.	56-002021.0000	39,522
Luke Air Force Base	56-002022.0000	1,295
Mar West Landowners Assoc.	56-002184.0000	31

Water Provider	Right Number	GW Demand (af/yr)
McCormick Ranch Prop Own Assn	56-002188.0000	463
Mobile Gardens Wtr Improv Dist	56-002278.0000	28
Morristown Water Co.	56-002324.0000	21
New River Utility Co	56-002254.0000	2,019
Olive Avenue Homeowners Assoc.	56-002194.0000	13
Park Shadows Country Homes	56-002028.0000	55
Pecos Ranchos Association	56-002199.0000	3
Peek-A-Boo Water Co-Op	56-002200.0000	22
Pima Utilities Company	56-002031.0000	6,642
Quail Run Irrigation Assoc.	56-002275.0000	44
Queen Creek Water Company	56-002032.0000	18,456
Queen Valley DWID	56-002221.0000	144
Rancho Maria	27-700310	216
Rigby Water Company	56-002034.0000	420
Rose Valley Water Company	56-002263.0000	2,359
Sabrosa Water Company (Global)	56-002209.0000	12
Saguaro Acres Communities Facilities District	56-002210.0000	38
Saguaro Management, Inc.	56-002282.0000	56
Shangri-la Ranch	56-002319.0000	10
Sun Haven Ranch (B-5-2) 17,19,20,21	28-400858	5,410
Sunburst Farms East	56-002214.0000	306
Sunburst Farms West Mutual Water Company	56-002215.0000	340
Sunrise Water Company	56-002041.0000	1,475
Thunderbird Adventist Academy	56-002284.0000	88
Tierra Buena Water Co.	56-002339.0000	131
Town Of Buckeye	56-002006.0000	19,047
Tres Rios Homeowners Association, Inc. (A-1-1)28	56-000000	57
Turner Ranches Wtr & Sanit. Co	56-002045.0000	1,633
Valencia Water Company	56-002046.0000	8,826
Valley Utilities Water Company	56-002047.0000	1,197
Walden Ranch	27-700412	1,048
Water Utility of Greater Buckeye	56-002288.0000	46
Yingling, Harold	56-002224.0000	8
	TOTAL	**269,812**